SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

MARCH 1900.

GENERAL PHYSICS.

612. *Viscosity.* **T. E. Thorpe.** (Roy. Instit., Proc. 15. pp. 641–660, 1899.)—The author gives an account of the main results of the investigations on the connection between viscosity of liquids and chemical nature carried out by himself in collaboration with the late J. W. Rodger. An improved form of apparatus was used which enabled a series of successive measurements with the same liquid to be rapidly made without disturbing the apparatus in any way (*i.e.*, for refilling, &c., as in the ordinary forms). For each liquid the absolute viscosity-coefficients were determined at various temperatures, the apparatus being immersed in a water or glycerine bath, which was kept at a uniform temperature by stirrers driven by a small turbine. A curve is given showing the viscosity of water at temperatures between 0° and 100° C., and in connection with this the author gives an interesting account of the various "abnormalities" exhibited by water, and how they can be explained by the assumption of the existence of molecular complexes. A tabulated list is given of the constants in Slotte's formula, $\eta = C/(1 + bt)^n$, for the various substances examined. The author then discusses the question as to what temperatures are to be regarded as "corresponding" for the purpose of making stoechiometrical deductions, and gives finally a list of *fundamental viscosity-constants* corresponding to equal values of $\frac{d\eta}{dt}$. From these it is possible to calculate values for the viscosities of most of the substances examined which are in very fair agreement with the observed values. F. G. D.

613. *Soap Emulsions.* **F. G. Donnan.** (Zeitschr. Phys. Chem. 31. pp. 42–49, Dec. 22, 1899.)—The author allows a definite volume of olive or rape oil to flow from a pipette with a turned-up end through alkali solutions of varying strengths, and counts the number of drops formed in each case. In the case of the ordinary rape oil of commerce the number of drops increases with the concentration of the alkali solution; thus with water 88 drops are obtained, whilst with a caustic soda solution containing 0·0011 gram-molecules per litre the number of drops is 480. Similar behaviour is observed when sodium carbonate, borax, and other sodium salts which suffer hydrolytic dissociation in aqueous solution are employed. These results—as well as those of further measurements made by the author, of the heights of balancing

columns of a hydrocarbon solution of stearic acid in one limb, and an alkali solution in the other limb, of a capillary U-tube—show that to increasing concentration of the alkali solution corresponds a decreasing surface tension between the oil and the solution, due to the formation of a soap by the action of the alkali on the free acid of the oil. When purified neutral rape oil is used the number of drops formed in soda solution is sensibly the same as in water, whilst lauric acid and the fatty acids with higher molecular weight, when dissolved in a neutral hydrocarbon of the paraffin series, exhibit behaviour similar to that of commercial rape oil.

The author compares his results with those of Krafft on the boiling-points of soap solutions, with those of Rayleigh on the formation of froth on liquids, and with Hall's observation of the concentration of soap in the surface layers of a solution, and concludes that this surface concentration causes a considerable diminution in the amount of work necessary to increase the surface of separation of an oil and alkali solution, and that it is to this that the formation of small bubbles is due. T. H. P.

614. *Action of Matter upon Ether.* **G. Sagnac.** (Comptes Rendus, 129. pp. 818–821, Nov. 20, 1899.)—The author shows that Fizeau's effect, in which the ether is apparently dragged along by a column of water in motion, consists of two effects which are opposed to each other. One is the mass effect, which, owing to the diminution, by its motion, of the useful mass of water traversed by the ray, produces an apparent dragging of the ether. The other is the motion effect, which is the same as if the cylinder containing the water moved with respect to the source, without any water entering or leaving it. The whole effect is a retardation in the time of propagation equal to—

$$\frac{Lv}{V^2}-\frac{Lv}{V_0^2}=\frac{Lv}{V_0^2}\left(n^2-1\right)$$

where L is the length of the column, V the speed of propagation in water, V_0 that in a vacuum, and v the velocity of flow of the water. E. E. F.

615. *Lippincott Planimeter.* **A. G. Greenhill.** (Engineer, 88. pp. 614–615, Dec. 22, 1899.)—This instrument is a modification of the Hine-Robertson planimeter; the two arms are jointed as in the Amsler planimeter, but whereas in the Amsler planimeter the area is estimated by the rolling of a wheel, and the side-slip of the wheel on the paper is ignored, the side-slip of the wheel on the paper is here eliminated and the area is estimated by the sidelong movement of the wheel on a bar carrying a graduated scale. This bar is made of a glass tube with scales marked on a piece of card sealed up inside, and is placed at right angles to that carrying the tracing-point. Three of these scale tubes are provided with the instrument, each marked with two different graduations; the mean effective pressure in an indicator diagram may therefore be read off directly for the springs in common use. A neat arrangement is provided for setting the instrument to any desired scale of measurement.

An elementary geometrical theory of the instrument is given in the paper, also references to other explanations of the theory of planimeters. A. S.

616. *Daily Registration of the Chromosphere.* **H. Deslandres.** (Comptes Rendus, 129. pp. 1222–1225, Dec. 26, 1899.)—The author, during his sojourn at the Paris Observatory, organised a system of regularly photographing the

surface and chromosphere of the sun by means of the "spectroheliograph," invented by himself and G. E. Hale, of Chicago, in 1892. Having now moved to the Observatory of Meudon, under the directorship of Janssen, he has again organised the carrying out of the same routine, but, owing to the different equipment available, the apparatus used is unlike that at Paris. Instead of a horizontal heliostat, a polar heliostat is now used, the reflected beam being therefore inclined downwards parallel to the earth's axis. The whole of the spectroscope, with its two slits, has therefore to be moved along a plane parallel to this. The objective throwing the image of the sun on the slit plate is 0·20 m. aperture and 3·20 m. focal length, and, the spectrograph itself magnifying three times, the final image of the sun on the plate is 92 mm. in diameter, considerably larger than previously. The author describes the evidence shown of a permanent "chromospheric réseau" or "mottling," independent of the solar sunspot period. (See also 1898, Abstract No. 899.)
C. P. B.

617. *Solar Influence on Barometric Movements.* **A. Poincaré.** (Comptes Rendus, 129. pp. 1290–1294, Dec. 26, 1899.)—The author plots out the curves of barometric pressure throughout the year for intervals of latitude of 10°. Taking the time and season of each set of movements, he finds a connection between them and the position of the sun and moon. The effect is ascribed in the case of the moon to the actual attraction of that body, while the effect of the sun is thought to be indirectly due to the heating and cooling produced by the varying positions of the earth during its rotation and revolution.
C. P. B.

LIGHT.

618. *Optical Constants and Dispersion of Camphor Derivatives.* **A. Haller** and **P. T. Muller.** (Comptes Rendus, 129. pp. 1005–1008, Dec. 11, 1899.)—The authors have determined the refractive indices, dispersions, and rotatory powers of a number of alkylcamphors obtained by the reduction of the compounds formed by the condensation of camphor with aromatic aldehydes. The results confirm the conclusion that the high values found for the physical constants in question in the case of these latter compounds are due to the presence of a double, or ethylenic, atomic linkage. N. L.

619. *Refractive Indices of Metals.* **E. van Aubel.** (Zeitschr. Phys. Chem. 30. pp. 565–566, Dec. 1, 1899.)—The refractive indices of a number of metals are here calculated from the refractive indices of salts of the metal, either in the solid state or in a state of solution. The values obtained are compared with Drude's experimental results, but there is no sort of agreement between them.

Kundt's theory, that the product of refractive index and electric conductivity of metals should be constant, does not at all agree with Drude's results, nor does it agree any better with the values of the refractive index calculated in this paper. J. B. H.

620. *Binocular Magnifying Glass.* **E. Berger.** (Comptes Rendus, 129. pp. 821–823, Nov. 20, 1899.)—Endeavours have been made to construct a binocular apparatus for the use of watchmakers and others which should have a low magnifying power and a large field of view. In his apparatus the author uses eccentric convex lenses, inclined to the line of view, so as to increase the angle of incidence and the prismatic effect of the lenses. The inclination of the lenses should be so chosen as to counteract any effect of astigmatism, either in the observer's eye or in the lenses themselves. E. E. F.

621. *Colour Photography.* **L. Vidal.** (Scientific American. 81. pp. 234–235, 1899.)—The paper, read before the Photographic Club of Paris, gives working details of a method of preparing photographic transparencies in natural colours. Three negatives are taken through three coloured screens, and from these positives are printed on bichromate-sensitised films. The positives are dyed with the complementary colours of the screens with which they were obtained, and superposed. Formulæ are given for the colouring solutions. G. H. B.

622. *Propagation of Light.* **J. Boussinesq.** (Comptes Rendus, 129. pp. 859–864, Nov. 27, and pp. 905–911, Dec. 4, 1899.)—A mathematical investigation of the propagation in a heterogeneous transparent medium of a laterally limited pencil of parallel light, the integration of the equations of motion being given. In the second portion the author discusses the justification of the principle of Fermat on the economy of time in the transmission of luminous motion across a heterogeneous medium which is also transparent and isotropic. These papers are a continuation of a previous one (Comptes Rendus, 129. pp. 794–798, Nov. 20, 1899). J. J. S.

623. *Polarisation Photometer.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 1. pp. 204–208, 1899.)—The working parts of this photometer are contained in a tube which can be turned about its axis, the angle being measured on a circular scale. The lights to be compared are admitted through two openings at the end of the tube and passed successively through an objective, a Wollaston prism, a biprism, an analysing Nicol, and two lenses forming a Ramsden's eyepiece. The instrument in some respects resembles the spectro-photometer of König, but important advantages are claimed for it as regards speed and certainty of working, due to the fact that the biprism and the Wollaston prism are adjustable at different angles, affecting the sensitiveness and speed of action. The adjustment for equality of the two halves of the field is effected by turning the analysing nicol through an angle indicated on one of the scales of the instrument. The instrument is so constructed that its working tube can be pointed in any direction, so that, for instance, the light coming from a particular part of the sky, or that from a luminous surface, can be examined with equal convenience. A brief description is given of five uses to which the instrument can be put: (1) Detection of the plane of polarisation of a source of plane polarised light; (2) Measurement of the proportion of polarised to nonpolarised light; (3) Measurement of candle-power; (4) Measurement of the rotating power of a liquid; (5) Measurement of the absorption power of a substance. W. E. S.

624. *Rotatory Power and Pressure.* **L. H. Siertsema.** (Archives Néerlandaises, 3. pp. 79–87, 1899.)—The results are given of experiments on the effect of pressure on the natural rotation of the plane of polarisation in solutions of cane sugar. The experiments are considered with reference to the hypothesis of Tammann as to the influence which internal pressure exercises on molecular properties. According to this theory the coefficient of variation of specific rotatory power when an external pressure is exerted should be the same as in the case of variation of internal pressure, and this last may be modified by the addition of sugar or any salt. The author concludes that in the variations which the specific rotatory power undergoes through pressure, change of concentration and the addition of an inactive salt, there are involved phenomena more complicated than the theory of Tammann is capable of explaining. J. J. S.

625. *Interferometer Study of Zeeman Effect.* **J. C. Shedd.** (Phys. Rev. 9. pp. 1–19, and pp. 86–115, 1899.)—The first portion contains an historical summary of the methods hitherto adopted, and an account of some preliminary experiments with Michelson's interferometer. The second part contains an account of the work done with the interferometer for the purpose of determining the relation, at different temperatures, of the magnetic displacement to the strength of field, and of measuring the displacement and determining the ratio e/m. The values obtained for the magnetic displacement show that any classification based upon this alone is of small value; but that a classification based upon the value of e/m gives groups of lines identical with Michelson's three types of lines. The complexity of structure also depends upon the value of e/m. The method adopted is similar to existing interferometer methods, but is claimed to be specially adapted to the problem attacked. E. E. F.

626. *Anomalous Dispersion.* **E. Aschkinass.** (Ann. d. Physik, 1. 1. pp. 42–68, Jan. 1900.)—The electromagnetic theory of dispersion leads to the

conclusion that anomalous dispersion must occur in the infra-red spectrum whenever the value of the refractive index for waves of infinite length, derived from Cauchy's formula by extrapolation, is not equal to the square root of the dielectric constant. This consideration was utilised by the author as a guide in the selection of substances in which anomalous dispersion might be expected. To discover this anomalous dispersion the author employs the method of multiple reflection. He thus found a number of anomalous dispersion bands in quartz, mica, fluorspar, marble, gypsum, alum, rock-salt, sylvine, and the bromides of sodium and potassium. Those in quartz occurred at 8·50, 9·02, and 20·75 μ, while that in potassium bromide occurred at the extreme region of measurable rays, between 60 and 70 μ. E. E. F.

627. *Chemical Action of Röntgen Rays.* **P. Villard.** (Comptes Rendus, 129. pp. 882-883, Nov. 27, 1899.)—Not only do Becquerel rays exert a well-defined chemical action (see 1899, Abstract No. 1144), but, as the author shows, Röntgen rays also exert a chemical action, not only upon photo-sensitive salts, but upon substances contained in some kinds of glass. He expresses this fact drastically by saying that radiographs can be obtained with simple glass plates instead of sensitive plates. The colouring action of Röntgen rays upon the tubes generating them is well known. The portion of the tube which lies in front of the plane of the antikathode takes a violet or brown tinge according to the composition of the glass. Villard encloses the antikathode in a wide tube, and protects the inner surface of the latter from the action of diffused kathode rays by a lining of aluminium foil. In that case only a violet colouring is produced, even in ordinary lead glass. On removing the aluminium lining the lead glass is coloured brown, owing to the oxidation of the lead by the diffused kathode rays. No colour is produced behind a platinum screen. The author proposes to make a silicate in which the reducing action should be more pronounced and apparent. E. E. F.

628. *Influence of Röntgen Rays upon Selenium.* **Perreau.** (Comptes Rendus, 129. pp. 956-957, Dec. 4, 1899.)—The author made the simple experiment of exposing a selenium cell to the action of an X-ray tube at a distance of 5 cm. Its resistance fell "rapidly" from 40,000 ohms to 34,000 ohms, and kept oscillating slightly about the latter value, owing probably to variations in the intensity of the rays. When the rays ceased, the cell regained its normal conductivity more slowly than it does after the impact of light. The reduction in the resistance was the same as would be produced by a gas-jet placed at a distance of 1·5 m. The action of the Röntgen rays diminished with increasing distance, but was still sensible at 17 cm. The author made sure that the effect was not due to secondary causes. Electric waves do not affect the resistance of selenium. E. E. F.

629. *Magnetic Deflection of Becquerel Rays.* **H. Becquerel.** (Comptes Rendus, 129. pp. 996-1001, Dec. 11, 1899.)—A small piece of radio-active barium, wrapped in aluminium foil, is placed in the centre of an iron disc forming one pole-piece of a strong electromagnet. The other pole-piece carries a fluorescent screen. When the magnet is not excited a faint and widely dispersed luminosity is found on the screen. As soon as the magnet is excited the luminous area contracts and becomes more intense. It is immaterial how the magnet is excited, as a reversal of the poles does not affect the result. Sensitive plates show the increase of intensity very clearly. With a distance of 15 mm. between the pole-pieces, a strongly marked negative is obtained in a minute and a half. When the rays pass across the magnetic lines of force, and not along them, the rays, after proceeding upwards from the source, curve round like projectiles and impinge upon the plate along a curve extending from one pole to the other, and bending out of the way of the radiant substance in the centre. The properties described are analogous to those of kathode rays. E. E. F.

630. *Magnetic Deflection of Becquerel Rays.* **H. Becquerel.** (Comptes Rendus, 129. pp. 1205–1207, Dec. 26, 1899.)—The author describes some further interesting qualities of the rays named after him. It appears that their magnetic deflection is a property varying from one radiant preparation to another. Polonium preparations show no traces of deflected rays in the most powerful magnetic field, whereas radium preparations show very distinct magnetic deflection. This would point to the conclusion that the difference between Röntgen and Becquerel rays is, after all, a quantitative rather than a qualitative one, and absorption and magnetic deflection appear to go hand in hand. Another striking experiment described by the author is the following: A piece of radium preparation is placed in a uniform magnetic field, and a photographic plate near it with its plane normal to the lines of force. The result is "an intense impression, limited by a spiral whose sense is that of the current which produces the field." This spiral is the trace, deformed by the field, of the line of intersection of the vertical plate and the plate on which the radium rests. If it could be proved that the radiation transports charged particles which are deflected by an electrostatic field it would be possible to form an estimate of the velocity of the rays. But the experiments undertaken hitherto in this direction have not given any indication of electric deflection or electric charges. The curves obtained in the photographs show that the speed of propagation of radium radiation is of the order of the speed of rotation communicated by a magnetic field of about 4,000 units. If it is admitted that in a field in air of unit strength the speed of rotation of the magnetic whirls is $2\pi \times 6{\cdot}6 \times 10^5$ per second, the velocity of the radium rays comes out very near the velocity found for kathode rays. E. E. F.

631. *Radio-active Substance emitted from Thorium Compounds.* **E. Rutherford.** (Phil. Mag. 49. pp. 1–14, Jan. 1900.)—Besides the ordinary radiation from thorium compounds, similar to that from uranium, it is found that they continuously emit radio-active particles of some kind, which retain their radio-active powers for some minutes. This emanation has the power of ionising the gas in its neighbourhood and of passing through thin layers of metals, and with great ease through considerable thicknesses of paper. The emanation gradually loses its radio-active power. It passes through a plug of cotton-wool without any loss of its radio-active powers. It is also unaffected by bubbling through hot or cold water, weak or strong sulphuric acid. In this respect it acts like an ordinary gas and differs from an assemblage of ions.

It is suggested that the emanation may possibly be a vapour of thorium, but on trial it was found that the amount of the emanation from thorium oxide was not sufficient to appreciably alter the pressure of the gas in an exhausted tube, and the spectrum of the gas was unchanged. The positive ion produced in a gas by the emanation was found to possess the power of producing radio-activity in all substances on which it fell. This power of giving forth a radiation lasts for several days. J. J. S.

632. *Phosphorescence Produced by Radiation from Radium.* **H. Becquerel.** (Comptes Rendus, 129. pp. 912–917, Dec. 4, 1899.)—Various substances were exposed to the action of the radiation given out by an active specimen of the chloride of barium containing radium. The materials used included hexagonal blende, platinocyanide of barium, diamond, double sulphate of uranium and potassium. The phosphorescence produced varied in the different cases. When screens of different nature were interposed between the radiating source and the phosphorescent bodies it was found that there was an absorption relatively unequal by the same screen of the radiation which excited the phosphorescence of the different substances. It seems that each substance is excited by a particular radiation, and it may be concluded that radiations of different nature proceed from the radiating source, which are characterised by their absorption, and are analogous to the radiations of different wave-length from a beam of white light.

In certain minerals there is a considerable persistence of the phosphorescence excited by radium.

A large number of bodies when exposed to the influence of radium acquire a temporary power of rendering the air conducting and can discharge electrified bodies at a distance. These facts afford new proofs of the reality of a continuous emission of energy by radio-active bodies. They show, moreover, the existence in this emission of particular radiations characterised by their selective absorption. J. J. S.

633. *Chemical Effect of Becquerel Rays.* **P.** and **Mme. Curie.** (Comptes Rendus, 129. pp. 823–825, Nov. 20, 1899.)—The rays emitted by very active radiant salts of barium are capable of transforming oxygen into ozone. When the salts are kept in a stoppered bottle, the smell of ozone is perceived on opening it. This was first observed by Demarçay. Potassium iodide paper is coloured blue. It is only the luminous radio-active preparations which produce this effect, but it is more the radio-activity than the luminosity which is effective, since highly luminous preparations are often less chemically active than those of inferior luminosity. Another chemical effect produced is the violet colouration of the glass in contact with the salt. The violet colour gradually penetrates the glass, and deepens in shade, finally becoming nearly black. There is also an effect of the rays upon barium platinocyanide screens, which gradually turn yellow and brown under their influence and lose their power of fluorescence. But this is immediately restored by exposure to sunlight. Of all these effects the production of ozone is the most significant, as it implies a continuous expenditure of energy.

E. E. F.

REFERENCE.

634. *Diffused Reflection of Light on Matt Surfaces.* **H. R. Wright.** (Phil. Mag. 49. pp. 199–216, Feb., 1900; also Ann. der Physik, 1. 1. p. 17, 1900.)—Paper referred to in Abstract No. 462 (1900).

HEAT.

635. *Thermal and Dynamic Coefficients.* **J. E. Trevor.** (Journ. Phys. Chem. 3. pp. 573–576, Dec. 1899.)—In a former paper (see 1900, No. 71), the author considered the four thermodynamic coefficients, p, v, θ, η, which are connected by two independent relations, namely, $f(p, v, \theta) = 0$, and $\phi(\eta, v, \theta) = 0$. From these he formed four derived functions, E, F, G, H, of which E, the energy, satisfies the equation—

$$d\mathrm{E} = -p\,dv + \theta\,d\eta.$$

These four are called the fundamental functions. In the former paper p, v, θ, η, and their derivatives, were expressed as partial derivatives of E, F, G, H. It appeared that these derivatives fell in a remarkable way into three groups. In the present paper he explains why this is the case.

Using—

$$d\mathrm{E} = -p\,dv + \theta\,d\eta,$$

and—

$$\left.\begin{aligned} dp &= \frac{\partial p}{\partial v}dv + \frac{\partial p}{\partial \eta}d\eta \\ d\theta &= \frac{\partial \theta}{\partial v}dv + \frac{\partial \theta}{\partial \eta}d\eta \end{aligned}\right\}$$

he finds twelve derivatives of E in three groups, namely, (1) Second derivatives; (2) Ratios of second derivatives; (3) Ratios of second derivatives to the Hessian.

S. H. B.

636. *Deviation from Boyle's Law in Mixtures of Hydrogen and Carbon Dioxide.* **J. E. Verschaffelt.** (Zeitschr. Phys. Chem. 31. pp. 97–102, Dec. 22, 1899.)—According to the theory of van der Waals the characteristic equation for a mixture of gases may be put in the same form as for a simple gas, the constants a_x and b_x having, for each molecular fractional composition x, values which are quadratic functions of the values of a and b for the pure gases. The experimental information is hardly sufficient to distinguish the parts played by a and b in the equation separately, but for large volumes it takes the form—

$$pv = \mathrm{RT} + \frac{\mathrm{RT}\,b_x - a_x}{v} = \mathrm{RT} + \frac{m}{v},$$

where the "normal" volumes (*i.e.*, volumes at 0° and 1 atmo.) are taken as unity. If instead of this we take the "theoretic" volume (v'), *i.e.*, the volume the gas would occupy at 0° and 1 atmo. according to Avogadro's law if it were a perfect gas, we have $pv' = \mathrm{RT}$, and hence—

$$pv - \frac{m}{v} = pv'.$$

Now for hydrogen Amagat finds $b = 0{\cdot}00069$, $a = 0$: for carbon dioxide van der Waals finds from Regnault's data $a = 0{\cdot}00874$, $b = 0{\cdot}0023$; whence $m = -0{\cdot}00644$.

An observation by Braun on the increase of pressure of a mixture in equal volumes of hydrogen and carbon dioxide—amounting to 0·0014 of the total—may be expressed according to the quadratic formula by taking—

$$0{\cdot}99931 + 0{\cdot}0060\,(1 - x)^2$$

as the deviation from the law of Arogadro. The author has made experiments (Proefschrift, Leiden, 1899) on the isothermals of the mixed gases at 18° between $v = \infty$ and $v = 0{\cdot}01$ expressible by the formula—

$$pv = \mathrm{RT} + \frac{m}{v} + \frac{n}{v^2}$$

where the larger coefficient m agrees very closely with the quadratic function

$$m = 0{\cdot}00074\, x^2 - 0{\cdot}0012\, x\, (1 - x)^2 - 0{\cdot}0063\, (1 - x^2)$$

deduced from Braun's observation. R. A. L.

637. *Comparison of Platinum and Gas Thermometers.* **J. A. Harker** and **P. Chappuis.** (Roy. Soc., Proc. 65. pp. 327-329, 1899.)—In the words of the original, "The present paper is the outcome of the co-operation of the Kew Observatory Committee and the authorities of the International Bureau of Weights and Measures at Sèvres, for the purpose of carrying out a comparison of some platinum thermometers with the recognised international standards.

"A new resistance-box, designed for this work, and special platinum thermometers together with the other accessories needed were constructed for the Kew Committee, and after their working had been tested at Kew, were set up in the laboratory at Sèvres in August, 1897. The comparisons executed between these instruments and the standards of the Bureau may be divided into several groups. The first group of experiments covers the range —23° to 80°, and consists of direct comparisons between each platinum thermometer and the primary mercury standards of the Bureau. Above 80° the mercury thermometers were replaced by a gas-thermometer constructed for measurements up to high temperatures. The comparisons between 80° and 200° were made in a vertical bath of stirred oil, heated by different liquids boiling under varying pressures. For work above 200° a bath of mixed nitrates of potash and soda was substituted for the oil tank. In this bath comparisons of the two principal platinum thermometers with the gas-thermometer were made up to 460°; and with a third thermometer, which was provided with a porcelain tube, we were able to go up to 590°. Comparisons of the platinum and gas-scales were carried out at over 150 different points, each comparison consisting of either ten or twenty readings of the different instruments.

"By the intermediary of the platinum thermometers a determination of the boiling-point of sulphur on the nitrogen scale was also made. The mean of three very concordant sets of determinations with the different thermometers gave 445·27° as the boiling-point on the scale of the constant volume nitrogen thermometer, a value differing only 0·7° from that found by Callendar and Griffiths for the same temperature expressed on the constant pressure air scale.

"If for the reduction of the platinum temperatures in our comparisons we adopt the parabolic formula, and the value of δ obtained by assuming our new number for the sulphur-point, we find that below 100° the differences between the observed values on the nitrogen scale and those deduced from the platinum thermometer are exceedingly small, and that even at the highest temperatures the differences only amount to a few tenths of a degree."

R. A. L.

638. *Surfusion.* **R. Moreschini.** (Accad. Lincei Atti, 9. pp. 13–16, Jan. 7, 1900.)—Mixtures of fatty acids obtained from soap exhibit the phenomenon of surfusion, the point of solidification varying with the method of determination used. When such a mixture, placed in a tube surrounded by a constant temperature air-bath (conveniently 15° below the melting-point), is heated to, say, 15° above its melting-point and then allowed to cool, the rate of cooling diminishes regularly as the temperature falls until the melting-point is nearly reached, when a sudden diminution occurs; cooling afterwards proceeds regularly, although more slowly than before. It is found that this behaviour is also shown by other bodies capable of existing, permanently or temporarily, in a state of surfusion. In the case of pure substances, however, the change occurs just at the melting-point, whilst with mixtures of fatty acids, especially if much oleic acid is present, it appears at a temperature slightly (about 0·15°) above the melting-point. T. H. P.

639. *Colours of Heated Steel Corresponding to Different Degrees of Temperature.* **M. White** and **F. W. Taylor.** (Indus. and Iron, 27. p. 398, Dec. 15, 1899. Paper read before the American Society of Mechanical Engineers.)—Estimations of the temperature of heated steel by the eye vary considerably with different observers and with the quality or intensity of the light in which the observations are made, but from a number of experiments with the Le Chatelier pyrometer the following colour scale is considered as best suited to the conditions met with in most workshops. The temperatures are given in degrees Fahrenheit. Dark blood red, black red, 990°; dark red, blood red, low red, 1,050°; dark cherry red, 1,175°; medium cherry red, 1,250°; full cherry red, 1,375°; light cherry, bright cherry, scaling heat, light red, 1,550°; salmon, orange, free scaling heat, 1,650°; light salmon, light orange, 1,725°; yellow, 1,825°; light yellow, 1,975°; white, 2,200°. N. L.

640. *Change of Thermal Conductivity on Melting.* **E. van Aubel.** (Zeitschr. Phys. Chem. 30. pp. 563–564, Dec. 1, 1899.)—Some substances show no noticeable change on melting, but ice shows a very large change, having the value 0·30 a little below zero while water has 0·0722 at 0°. R. A. L.

REFERENCE.

641. *Thermal Expansion of Nickel and Cobalt.* **A. E. Tutton.** (Roy. Soc., Proc. 65. pp. 306–312, 1899.)—Contains numerical data of the experiments referred to in Abstract No. 1488 (1899). R. A. L.

ELECTRICITY.

642. *Luminosity of Gases under Discharge.* **J. Stark.** (Ann. d. Physik, 1. pp. 424–429, Feb., 1900.)—Wiedemann has shown that the temperature of a gas showing the ordinary vacuum phenomena is in general below 100°. He concluded that the luminosity is not a phenomenon of incandescence, but of phosphorescence. This conclusion has since been corroborated, but the experiments are complicated by the fact that the introduction of a hot body in itself reduces the discharge potential and increases the current through the tube. The author introduces independent carbon filaments into the tube and heats them to white heat by a current, a red heat producing no effect. He finds that if the filament is in the region of positive light it reduces or extinguishes the light. If it is stratified the filament cuts pieces out of the bright strata. A short positive column is totally extinguished by the filament. The negative light is enfeebled, but the luminescence of the walls is unaffected, thus showing that the kathode rays remain uninfluenced. The heating simply deprives the gas of its power of phosphorescence under discharge. Knowing that a rarefied gas is ionised by heating, we must conclude that an ionised gas does not phosphoresce under the influence of the discharge. This, again, indicates that the phosphorescence is a molecular phenomenon. E. E. F.

643. *Revision of Electrical Units.* **R. A. Fessenden.** (Electrician, 44. p. 336, Dec. 29, 1899.)—The author has discovered a way of eliminating 4π from the formulæ defining electric units without changing any of the legal units. It consists simply in taking the magnetic permeabilities of the ether as $(4\pi)^2$ instead of unity. This produces no change in the units of current and voltage. The unit of difference of magnetic potential becomes 4π times as large as the former unit. The new unit is in fact the ampere-turn, which is already used in practice. The distinction between magnetic or electric flux and quantity disappears, and with it no less than twenty-six separate and distinct terms.

The author also proposes a new nomenclature for the absolute electromagnetic and electrostatic units, which should be used instead of the "practical" units. The unit of difference of electric potential should be the Volma or Volsta, in the electromagnetic and electrostatic system respectively. Further, the author has designed a system of suffixes to denote space, area, volume, and time differentials. E. E. F.

644. *Resistance and Residual Charge of Liquid Dielectrics.* **A. Naccari.** (Accad. Sci. Torino, Atti, 34. 15*a*. pp. 820–833, 1898–99.)—Experiments on xylol, toluol, benzol, and various petroleums show that rise of temperature produces an increase of conductivity of the same order as that in electrolytes, and greater in proportion to the original resistance. In dielectrics of high resistivity the residual charge is also high. It diminishes with increasing temperature, but not in proportion to the diminution in the resistance. Residual charges are possibly due to some lack of homogeneity in even a simple liquid. E. E. F.

645. *Internal Resistance of Daniell Cell.* **E. Cohen.** (Zeitschr. Phys. Chem. 31. pp. 164–175, Dec. 22, 1899.)—This paper starts with the description of an electrical method of determining the temperatures at which internal changes take place in saturated solutions. The method is similar to that used by Dawson and Williams (see 1900, Abstract No. 240). It is here applied to the case of a Daniell cell to test whether the temperature-coefficient of internal resistance is constant.

A curve is given for the resistance of a saturated solution of $CuSO_4 . 5 H_2O$. This curve consists of two straight lines meeting at an angle at about 56° C. The temperature-resistance curve of a 5 per cent. solution of $ZnSO_4$ is approximately a straight line near 56° C. The temperature-resistance curve of a Daniell's cell (which is the sum of the ordinates of the above two curves) must therefore have an angular bend at about 56° C. J. B. H.

646. *E.M.F. of the Clark Cell.* **H. S. Carhart** and **K. E. Guthe.** (Phys. Rev. 9. pp. 288–293, Nov.–Dec., 1899.)—The E.M.F. was determined absolutely in terms of the P.D. of a known current through a known resistance. The value of the current was found by the form of electrodynamometer used by Patterson and Guthe in the determination of the electrochemical equivalent of silver (see 1899, Abstract No. 1727). The final result for the E.M.F. of a Kahle H-form, set up according to the specification legalised by Congress in 1894, is 1·4333 volts at 15°. If 0·0011187 be taken as the silver equivalent for a solution not neutralised by silver oxide, and the figure obtained by Glazebrook and Skinner in 1892, viz., 1·4342 volts, be recalculated, it becomes 1·4332 volts at 15°, which is practically identical with the above. W. R. C.

647. *Measurement of Induction by Voltmeter.* **H. N. Allen.** (Electrician, 44. pp. 108–109, Nov. 17, and 191–193, Dec. 1, 1899.)—The self-induction of an alternate current circuit can be determined by the use of a voltmeter and ammeter from the formula $E = C\sqrt{R^2 + p^2 L^2}$ provided there is no mutual induction between the circuit and the voltmeter leads. With a closed circuit this is easily ensured by carrying the voltmeter leads close together for some distance from the circuit. With a portion only of a circuit, to eliminate mutual induction the voltmeter leads must be carried along the line along which the line integral of the vector potential due to the main current is zero. This can only be determined in two or three simple cases. By solving the differential equation for an alternating E.M.F., the error is calculated in terms of induction coefficients for electrodynamic and hot wire voltmeters, and in terms of capacity and induction for electrostatic instruments. These results are compared with observations of voltage across a single bar of a drum armature. With a frequency of 213 ∿, the true value being 0·22 volts, readings ranging from 0·11 to 0·34 were obtained by carrying the leads along various paths according to whether the E.M.F. generated in the voltmeter leads by mutual induction assisted or opposed the main voltage. L. B.

648. *Measurements on High-Pressure Circuits.* **L. Schüler.** (Elektrotechn. Ztschr. 20. pp. 868–869, Dec. 14, 1899.)—The author describes the recently patented method of measuring P.D., current, and power on high-pressure circuits used by the Elektricitäts A.—G. It consists in using either a whole armature coil (if the number of poles is large) or part of one (if the number of poles is small) for purposes of measurement, this "measuring coil" being entirely disconnected from the main armature circuit. The coil is joined in series with a transformer whose ratio of transformation is unity, and whose secondary is inserted into the main circuit of the machine. A voltmeter connected across the terminals of the "measuring coil" reads a definite fraction of the high P.D.; an ammeter in its circuit reads the high-pressure current; and a wattmeter in the same circuit reads a definite fraction of the total power developed by the machine. A. H.

649. *Determining Faults in Dynamos.* **K. Richter.** (Elektrotechn. Ztschr. 21. pp. 38–42, Jan. 11, 1900.)—After discussing a bridge method of testing for faults in the armature and field-magnet windings of dynamos described by O. Frölich in a paper read before the Elektrotechnische Verein on the 20th of December, 1892 (see Elektrotechn. Ztschr. Heft 4, 1893), the author describes a method which he has devised and which has yielded satisfactory results in practice. This method consists in observing the fall of potential along a linear conductor of constant specific resistance which is traversed by the current, and indicating the results of the observations in the form of a potential line, *e.g.*, in testing for a fault in the armature of a dynamo one terminal of a battery is connected to the armature shaft or core and the other to a point in the winding; a shunt circuit containing a high resistance galvanometer is then connected at one end to a fixed point in the winding and the other end moved from point to point throughout the winding to find the point or points of maximum or zero potential, as the case may be. When these points are found, the position of the fault can be easily determined. The various cases arising in practice are fully discussed mathematically by the aid of diagrams. C. K. F.

650. *Resistances.* **Feussner.** (Elektrotechn. Ztschr. 20. pp. 611–613. Discussion, pp. 613–614, 1899. Paper read before the Elektrotechnische Verein, Berlin, April 25, 1899.)—The ordinary resistances, consisting of silk-covered wire, will not stand high pressures or even a moderate dissipation of energy without danger to their insulation. Their capacity is also considerable. To overcome these difficulties the author uses thin, bare, flat strips of high-resistance metal, as small as 0·03 mm. wide, wound on mica sheets 0·2 to 0·3 mm. thick, and held in place by varnish. Bifilar winding is impossible, as it brings the ends of a coil with the full voltage across them too near together. Such coils are practically inductionless and without capacity, and will stand a dissipation of energy up to 40 watts per square decimeter. The method of flattening the fine wire is described. Resistance boxes for various purposes and voltages up to 10,000 are illustrated. This form of resistance has been in use satisfactorily for some years at the Reichsanstalt and the Weston Company's works. A discussion followed. L. B.

651. *A Speaking Galvanometer for Warships.* (Electrician, 43. p. 919, 1899.)—As the siphon recorder is too delicate, and the mirror instrument requires too much skill to read, Sullivan uses a balanced d'Arsonval galvanometer, which is damped by pressing a camel's hair on the suspension; this gives damping which only breaks down when the current reaches a certain value; at the same time the damping due to a short-circuited coil in the field is diminished by making the short circuit through a platinum wire. No condenser or sending switch is necessary. An "Instruction" galvanometer is made, by which teachers can imitate the signals in long and short cables by altering the position of the camel-hair brush and using a coil with large magnetic damping. M. O'G.

652. *Vacuum Electroscope.* **H. Pflaum.** (Ann. d. Physik, 1. 2. pp. 290–298, Feb., 1900.)—The author produces a vacuum electroscope in the form of a pear-shaped bulb containing aluminium leaves attached to a thick aluminium wire, which projects outside the bulb and ends in a knob like that of an ordinary electroscope. In a good vacuum the leaves act more promptly and decisively than in air at ordinary pressures. The deflections are accompanied by a radiation of the electric charge on to the glass walls, which is, however, not accompanied by any luminosity. E. E. F.

653. *Frequency Meter.* **E. Stöckhardt.** (Elektrotechn. Ztschr. 20. pp. 873–874, Dec. 14, 1899.)—The principle of the instrument is identical with that of the Campbell Frequency Teller. An electromagnet whose coil is traversed by the alternating current is placed between the prongs of a rigidly fixed tuning-fork of wrought iron, and along the prongs may be slid simultaneously two riders which alter the period of the fork. The riders are provided with pointers moving along a scale, and they are moved by turning a cylinder to which are attached two fine wires connected to the riders. On the other side another couple of wires attached to the riders are coiled round another cylinder provided with a spring which tends to turn the cylinder so as to pull back the riders to the bend of the fork. The instrument is said to be very sensitive and to give a sharp maximum of sound. A. H.

654. *Graphical Treatment of Distorted Wave-Forms.* **R. Goldschmidt.** (Elektrotechn. Ztschr. 20. pp. 840–842, Nov. 30, 1899.)—The author explains a graphical method of finding the current-wave in an inductive circuit produced by an E.M.F. wave of irregular shape, without the necessity of having recourse to harmonic analysis. The method is an approximate graphical integration of the differential equation of current, and is based on the assumption that the E.M.F. wave consists of a broken straight line instead of a continuous curve. A. H.

655. *Resistance of Conductors to Alternating Currents.* (Ind. Élect. 8. pp. 556–557, Dec. 25, 1899.)—The author gives an approximate method of calculating the resistance of a cylindrical conductor to alternating currents which does not directly involve the resistivity of the material. Let $R_c =$ resistance of given conductor to continuous currents; $R_a =$ resistance of given conductor to alternating currents; $l =$ length of conductor, in kilometres; $p = 2\pi \times$ frequency; $a = \frac{pl}{R_c . 10^4}$, and $b = \frac{0{\cdot}2\pi}{p} \cdot \frac{R_c}{l} \cdot 10^4$. Then—

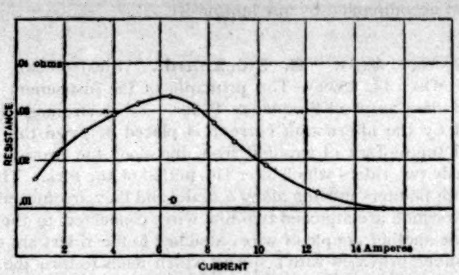
$$R_a = kR_c,$$

where, for values of $a > 25$, we may take $k = 0{\cdot}25 + \sqrt{\frac{a}{2}}$; for values of $a < 1$, $k = 1 + \frac{a^2}{12} - \frac{a^4}{180}$; and for values of a lying between 1 and 25, k is given by a table, part of which is here reproduced.

$a =$ 1	2	4	6	8	10	16	20	25
$b =$ 6·283	3·142	1·571	1·047	0·7854	0·6283	0·4488	0·3142	0·2513
$k =$ 1·078	1·265	1·678	2·007	2·274	2·507	3·095	3·415	3·735

A. H.

656. *Resistance of Iron Wires to Alternating Currents.* **E. Merritt.** (Phys. Rev. 9. pp. 294–299, Nov.–Dec., 1899.)—If iron wires are used to carry alternating currents, the resistance of the wire depends upon the frequency of the current and the permeability of the iron, in addition to the length, cross-section, and temperature. As the permeability depends upon the intensity of magnetisation, the resistance to heavy currents may be less than to moderate currents, even though the temperature is greatly increased.



This is shown in the curve given above, which was obtained experimentally by H. H. Denis, at the author's suggestion, with a wire 0·366 cm. in diameter, with an alternating current of frequency about 130 periods per second. The curve A shows the resistance offered to the alternating current, whilst the curve D shows the variation in resistance with current strength by using a direct current. The test was carried out by the Wheatstone Bridge method, a telephone being used for alternating currents. W. G. R.

657. *Magnetic Properties of Iron-Aluminium Alloys.* **S. W. Richardson.** (Phil. Mag. 49. pp. 121–154, Jan., 1900.)—The author determines experimentally the curves connecting the magnetising force and the magnetic induction in alloys of iron and aluminium over a range of temperature of — 83° C. to + 900° C.

The specimens tested contain respectively 3·64, 5·44, 9·89 and 18·47 per cent. of aluminium. The method of test was the use of a ballistic galvanometer and a secohmmeter. The specimens, which are in ring form, are wound with two coils, the secondary being of platinum, whose resistance is taken as a measure of the temperature. The chief results may be summarised as follows: (1) The alloys behave magnetically as though they consisted of two distinct media superposed. (2) The general roundness of the curves and their lack of abruptness near the critical point seem to indicate that the alloys are heterogeneous in structure. A similar lack of abruptness is noticeable in Hopkinson's curves for nickel-iron alloys. (3) The permeability decreases with rise of temperature near the critical point until a minimum value is reached, when any further rise of temperature produces very slight diminution, if any, in the permeability. (4) The experiments suggest that the maximum value of the permeability for an alloy containing 10 per cent. of aluminium is reached at about — 90° C. (5) An alloy containing 18·47 per cent. of aluminium has a critical point at about 25° C., and gives no indication of temperature hysteresis. This alloy probably has a maximum permeability at a temperature much below — 90° C. W. G. R.

658. *Magnetism of Bricks.* **O. A. Gage** and **H. E. Lawrence.** (Phys. Rev. 9. pp. 804–809, Nov.–Dec., 1899.)—The authors tested the magnetism of a number of bricks (at least thirty-two) of various qualities. All but one—nearly white—were found to be magnets. The poles were never in the ends of the bricks, but either in the faces or edges. The magnetic moments of the bricks were not constant, but varied from time to time, when kept under normal conditions. Heating temporarily diminished the magnetic moments. It is surmised that the magnetism is due to the presence of magnetic iron oxide, either as a component of the clay or developed by heat, and that the permanent magnetism arises from the cooling of the bricks in the earth's magnetic field. The positions of the poles may be explained by the way the bricks are laid in the kiln. A. G.

659. *Magnetic Elements in Northern Italy.* **E. Oddone.** (Accad. Sci. Torino, Atti, 34. 15*a*. pp. 799–819, 1898–99.)—Measurements of declination, dip, and intensity were carried out in 1898 in the districts of Feletto and Rivarolo Canavese, at a time free from magnetic disturbances. They yielded an important correction of the course of the isoclinic lines on the Italian charts. Thus the isoclinic 62·0° should run north of the stations mentioned, and not south. E. E. F.

660. *Magnets Used in the Determination of the Earth's Horizontal Magnetic Force.* **C. Chree.** (Roy. Soc., Proc. 65. pp. 375–413, Nov. 30, 1899.)—The values of the constants (temperature coefficient, induction coefficient, moment of inertia and distribution correction) of over a hundred collimator magnets of the Kew pattern have been determined at Kew Observatory, and in the present paper the author discusses the values obtained. The temperature coefficient is determined from observation at 0°, 18°, and 36° C., and the numbers obtained support the correctness of the parabolic formula employed for calculating the magnetic moment at any temperature for the magnetic moment at 0°. Attempts were made to deduce relations between the values of the different "constants," but they were not very conclusive, partly no doubt owing to the fact that the dimensions of the magnets are not recorded.

The author also discusses the probable errors introduced into the determination of the horizontal component owing to the possible errors which exist in the values of the "constants." In particular the effect of errors in the value assumed for the distribution constant (P), and also the approximations used in applying the correction for this are discussed, with the result that it is shown that a very appreciable error may easily be introduced on this account.

From a discussion of the observations made with the Observatory unifilar, the author concludes that the centre of the deflection bar is not vertically below the point of suspension of the fibre which carries the deflected magnet, and he discusses the effect of this asymmetry on the value obtained for H. W. W.

MEDICAL ELECTRICITY.

661. *Death by Electricity.* **R. H. Cunningham.** (Elect. World and Engineer, 34. pp. 1003–1004, Dec. 30, 1899.)—This may be called a "popular edition" of an article published in the New York Medical Journal of October 21 and October 28. It is the account of a series of experiments carried out to ascertain the mechanism of death by electricity.

Stated very briefly, and nearly in the author's own words, the conclusions are as follows: When the chest is traversed by a certain number of amperes, or fraction of an ampere, for a sufficient length of time, the most important effect produced is the immediate cessation of the co-ordinate beat of the heart. Consequently the circulation of the blood throughout the body ceases, and the various delicate nerve cells of the central nervous system die rapidly from the lack of indispensable blood. The action of the current upon the heart is clearly a physiological one, and the state produced in it is what physiologists term "fibrillation." Roughly speaking, in this condition the rhythmical synchronism of the contractions of the little muscle bundles of which the heart is composed is profoundly disturbed, and the contractions of the bundles fall out of phase. Thus the heart fails as a blood-pump, and death quickly ensues unless the circulation is restored.

The higher mammalia practically never recover spontaneously from this condition of fibrillation, but the lower the order of the animal the more likely is it to recover. Thus when guinea-pigs, rats, mice, turtles, frogs, and fish are subjected to strong currents, the permanency of the cardiac effects is less pronounced.

Owing to the small size of such animals, it is practically impossible to prevent a large part of the current from traversing the nervous system; and it is upon the latter that the physiological effect of the current chiefly falls. The result is then identical with that produced by passing the current only through the brain and upper part of the spinal marrow of a dog in such a fashion as not to include the heart in the circuit. When passed in this way through the brain comparatively weak currents (1 to 2 amperes) usually produce a more or less pronounced stoppage of the rhythmical respiratory movements during the time the current is passing. When the circuit is opened this so-called inhibitory effect passes off in a moment, and breathing becomes re-established. With very strong currents (6 to 12 amperes), usually one or more general convulsions follow the powerful stimulation of the cortex of the brain, and the respiratory inhibition is more pronounced; and if it persists long enough death results from asphyxia. If the latter be not too profound the animal can be restored by artificial respiration. When the circuit includes both brain and heart the effect is, of course, a combined one.

The author does not consider that consciousness is lost synchronously with the beginning of the shock, although the period of consciousness may be extremely brief. No reliable data can be given as to the minimum intensity of current necessary to produce cardiac fibrillation in man. Probably physiological susceptibility to the current varies. The 110-volt lighting current seems capable of electrocuting certain individuals. W. S. H.

662. *E.M.F's. of Muscle, from the Point of View of Diagnosis.* **M. Mendelssohn.** (Archives d'Él. Médicale, 8. pp. 1–13, Jan., 1900.)—The author has repeated the experiments of Hermann and others upon the E.M.Fs. developed in a muscle during its contraction, and applies them to the study of various paralytic conditions. He finds the most promising results in the examination of the diphasic wave of electromotive force which is set up in a muscle when its nerve is artificially stimulated. In a paralysed muscle the diphasic E.M.F. may cease to be proportionate to the degree of voluntary power which survives. In a muscle paralysed but preserving its electrical irritability the two phases are evident, and are still seen even when there is

atrophy of the muscle fibres. A notable decrease in the second phase in a paralysed muscle is a sign of approaching degeneration. In certain cases of atrophic paralysis a total disappearance of the second phase may be observed.
H. L. J.

REFERENCES.

663. *Thermoelectric Measurements.* **P. Straneo.** (N. Cimento, 10. pp. 269–276, 1899.)—Mathematical paper showing how, by a combination of the methods described in the *Lincei Atti* during two years past with the suggestions of Peterson in his inaugural dissertation *Ueber die Messung des Thomsonschen Effektes* (Zurich, 1895), it is possible to obtain accurate measurements of all the data required. The paper does not lend itself to abstracting. A. D.

664. *Magnetism of the Earth.* **Wessely.** (Archiv. Math. Phys. 17. pp. 116–117, 1899.)—A note on the earth's magnetism, as deduced from the earth's electrostatic change (calculated from the fall of potential in atmospheric electricity) taking into account the earth's motion. J. J. S.

665. *Plane Magnetisation of Pyrrhotine.* **P. Weiss.** (Soc. Franc. Phys., Séances, 2. pp. 87–90, 1899.)—Similar to paper referred to in Abstracts No. 718 (1899) and No. 525 (1900).

666. *Minimum Charging Current of a Condenser.* **A. Russell.** (Electrician, 44. p. 333, Dec. 29, 1899.)—This paper describes a graphic method of proving that the triangular form of P.D. wave is the one which produces the smallest effective current in charging a condenser to a given potential in a given time. J. B. H.

667. *Invention of the Coherer.* **C. Olivetti.** (Elect. World and Engineer, 34. pp. 858–859, Dec. 2, 1899.)—The invention of the coherer is claimed for T. C. Onesti in preference to Branly.

668. *Alternate Current Measurements.* **O. de Bast.** (Assoc. Ing. Él., Liège, Bull. 10 pp. 271–296, 1899; and 311–345, Jan., 1900.)—Elementary theoretical articles dealing with the principles underlying the measurement of current, voltage, and power, with a reference to various instruments used for these purposes.

669. *Radiographic Installation of the Val-de-Grace Military Hospital.* **E. Loison.** (Archives d'Él. Médicale, 8. pp. 20–29, Jan., 1900.)—A detailed description.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

670. *Velocity of Reaction in Heterogeneous Systems.* **H. Goldschmidt.** (Zeitschr. Phys. Chem. 31. pp. 235–249, Dec. 22, 1899.)—The velocity of saponification of ethyl acetate by hydrochloric acid and by baryta was measured in systems consisting partly of aqueous, partly of benzene solutions, in order to test the applicability of the law of mass action to such heterogeneous systems. Previous attempts in the same direction had been on solutions in contact with solid, but led to questionable results because saturation of a solution by solid is a slow process. Partition of a dissolved body between two solvents is much more rapid, so that the normal course of the reaction is less interfered with. For a monomolecular reaction this law of mass action leads to the same result as for a homogeneous system, except that the velocity is multiplied by $\frac{v_2 + v_1 C}{v_1 C}$ where v_1, v_2 are the volumes of the active solution (dilute acid) and neutral (benzene) respectively, and C the ratio of partition. This result was approximately verified for saponification by acid, but it is noted that on account of the insolubility of water in benzene, the concentration of ethyl acetate in it is large (for $\frac{\text{acid} \times \text{alcohol}}{\text{ester} \times \text{water}} = \text{constant}$), hence the reaction becomes practically a reversible one. By allowing for this much more constant values were obtained for the reaction constant, and the applicability of the law of mass action satisfactorily proved. The trimolecular reaction studied gave similar results. R. A. L.

671. *Partial Association of Liquid Molecules.* **J. J. van Laar.** (Zeitschr. Phys. Chem. 31. pp. 1–16, Dec. 22, 1899.)—Assuming, from Ramsay and Shields' results, that water, alcohol, &c., consist partly of simple molecules, partly of molecules Θ times as large, the equilibrium expressed by

$$(H_2O)_\Theta \rightleftarrows \Theta \,.\, H_2O$$

exists, and the reaction constant K may be calculated as a function of the degree of dissociation β in the usual way. The heat of dissociation is then a function of β, and, if $\frac{\delta \log K}{\delta \beta} \frac{d\beta}{d\tau}$ (τ = temperature) is small enough to neglect, may be calculated. Assuming that for water $\Theta = 2$ the author finds from Ramsay and Shield's values of the factor of association at different temperatures, that the heat of dissociation is 1930 cal. per 18 gms., for the range 0°–100°. At higher temperatures the value found increases—a result that is supposed to be due to the increasing inaccuracy of the assumption made, and of the experimental data. Ethyl alcohol is also found to consist of double molecules. Methyl alcohol must contain molecules of mass $3\,CH_3OH$: it gives more divergent results, which are perhaps attributable to a progressive dissociation into $2\,CH_3OH$ and finally CH_3OH.

In a mixture of alcohol and water the volume must be a function of the degree of association of the two substances. By assuming that the specific volume of simple and double molecules of each substance is the same in the mixture as in the pure state, and neglecting minor terms, consideration of the densities of dilute solutions of water in alcohol and of alcohol in water lead to the conclusion that 1 mol. (18 gms.) of water expands 8·44 c.c. on passing into the associated condition : 1 mol. (46 gms.) of alcohol 2·0 c.c. Using these numbers and the known association factor, it becomes possible to calculate the specific volumes of the simple and double molecules separately. The abnormal volume changes of water at low temperatures may be accounted for by supposing that the contraction due to breaking up of molecular complexes compensates for the expansion due to heat ; if this be done, the coefficient of expansion for water in the form of simple molecules is found as 0·000953 at 0° in agreement with the mean of five other liquids that have nearly the same critical point. R. A. L.

672. *Pseudo-Equilibria.* **M. Bodenstein.** (Zeitschr. Phys. Chem. 30. pp. 567–569, Dec. 1, 1899.)—This is a reply to Duhem's criticism (see 1900, Abstract No. 234). The author points out that the apparent equilibrium states observed by Pélabon can be only due to the small value of the reaction-velocity, since he has been able without difficulty to pass these supposed limiting states in his own experiments.

In answer to an objection of Duhem's, he states the quantities of sulphur employed by himself in his experiments on the combination of sulphur and hydrogen, and shows that the amount of sulphuretted hydrogen dissolved by these quantities would, according to Pélabon's own experiments, be very small. Duhem's main criticism appears therefore to be refuted. F. G. D.

673. *Numerical Laws of Chemical Equilibrium.* **O. Boudouard.** (Comptes Rendus, 130. pp. 132–134. Jan. 15, 1900.)—By means of le Chatelier's formula for the equilibrium of gaseous mixtures the author calculates the relative proportions of carbon dioxide and carbon monoxide in the gases resulting from the action of carbon dioxide on carbon at temperatures between 450° and 1050°, and obtains results agreeing well with the experimental values previously found. At 450° carbon dioxide is scarcely acted on by carbon, whilst at 1050° it is almost completely converted into monoxide ; between 650° and 700° the gases are present in equal volumes. N. L.

674. *Osmotic Pressure of Concentrated Solutions.* **T. Ewan.** (Zeitschr. Phys. Chem. 31. pp. 22–34, Dec. 22, 1899.)—By means of a reversible cycle the author obtains a general relation connecting the osmotic pressure of a solution with its freezing-point, in which no special assumption is made regarding the equation of state of the solute. In order to calculate the osmotic pressure from this relation it is necessary to know the freezing-point of the solution, the heat of dilution, the temperature-coefficient of the heat of dilution, the change of volume accompanying dilution, and also the heat of fusion, the specific heats in the solid and liquid states, and the freezing-point of the solvent.

The author describes his method of determining the freezing-points. The solution (or solvent) was contained in a glass tube, which was set inside a brass tube closed by a hollow glass stopper filled with a cryohydrate whose equilibrium-temperature was very near the required freezing-point. The brass tube was placed inside a glass vessel containing the same cryohydrate, and this glass vessel was in its turn immersed in a freezing-mixture of ice and salt.

The solute was cane sugar, and the solutions were analysed by drawing off a portion of the solution in equilibrium with the separated ice and determining its density. By means of his own results and other data the values of $\left(\frac{\partial P}{\partial T}\right)_v$ corresponding to various dilutions are calculated. It is found that these results can be expressed by the formula :—

$$\left(\frac{\partial P}{\partial T}\right)_v = \frac{R}{V - \frac{V - nM_o v_o}{m}}$$

Here $R =$ the gas constant (for hydrogen) $= 84820$ g. cm. ; $M_o =$ molecular weight of water ; $V =$ volume of solution containing 342 grms. of sugar and nM_o grms. water ; $nM_o v_o =$ increase of volume which would occur if nM_o grms. water were added to the solution without appreciably changing its concentration ; $m =$ grms. of water to 1 grm. sugar. Now from the free energy equation (*cf* Nernst, *Theoretische Chemie*) it follows that :—

$$Pv_o = T \frac{\partial}{\partial T}(Pv_o) + J \frac{\partial Q_T}{\partial m}$$

where $\frac{\partial Q_T}{\partial m}$ is the "instantaneous" heat of dilution at dilution m and temperature T. Hence combining both equations :—

$$P = \frac{RT}{V - \frac{V - nM_o v_o}{m}} + \frac{J}{v_o} \frac{\partial Q_T}{\partial m}.$$

In order to completely solve the present problem it would be necessary to be able to express $\frac{\partial Q_T}{\partial M}$ as a function of the concentration. F. G. D.

675. *Freezing-points of very Dilute Solutions.* **M. Wildermann.** (Zeitschr. Phys. Chem. 30. pp. 508-526, Dec. 1, 1899. Compare Roy. Soc., Proc., 1896.) —(1) When the freezing-point is depressed by about 0·02° ice separates in the form of needles or flakes throughout the solution, but if the depression is only a few thousandths, it separates in bands or in a continuous cap on the bulb of the thermometer. (2) The freezing-point of water, freed from ammonia and carbon dioxide by a current of pure air, varies to a noticeable extent owing to the presence in it of a variable amount of dissolved oxygen, and other non-electrolytic matter. (3) Care must be taken that the values of the freezing-point do not vary by more than a few ten-thousandths of a degree when repeated at intervals of 10 or 15 minutes, as otherwise an error is present, due to the distortion of the bulb by change of temperature. (4) The readings of the 1/1000°-thermometer are influenced to the extent of 0·0003° per mm. by variation in the height of the barometer. (5) The thermometer adjusts itself completely to alterations of pressure within two minutes. (6) An opposite effect, of exactly equal magnitude, is produced by the rise of the mercury column in the stem of the thermometer. (7) This effect is present also in the calibration of the thermometer ; but, since the change of pressure is proportional to the reading of the thermometer, and the effect is rapidly produced, scale-divisions of uniform length give correct readings, even when the length of the scale is different on different thermometers. (8) One mm. variation in pressure alters the reading of the 1/100°-thermometer to the extent of about 0·00015°. (9) Errors due to inexact calibration of pipettes, &c., are not more marked in very dilute solutions than in more concentrated. The author supposes that his method is accurate within 1, 2, or 3 ten-thousandths of a degree.

The author gives directions for the use of the thermometers, and discusses their accuracy. T. M. L.

676. *Cryoscopic Investigations on the Constitution of Acid-amides.* **K. Auwers.** (Zeitschr. Phys. Chem. 30. pp. 529–544, Dec. 1, 1899.)—Unlike the phenols, the thiophenols as a rule show a normal cryoscopic behaviour when dissolved in naphthalene, but abnormal values are obtained where negative groups are present—as, for instance, in thioacetic acid, $CH_3.CO.SH$.

Substitution only has the effect of diminishing the abnormality of a substance when the radicle is attached to the carbon atom adjacent to that which carries the group (OH or NH) responsible for the abnormal behaviour. Thus o-nitroacetanilid differs from acetanilid in that it behaves quite normally, but in o-nitrobenzylacetamide, $NO_2.C_6H_4.CH_2.NHAc$, the nitro-group is without influence, and the substance shows the same abnormal behaviour as benzyl-acetamide; similarly it is shown that the substituted benzaldoximes and benzylalcohols all show the abnormal behaviour of benzaldoxime and benzylalcohol, even when the substituting group is in the ortho-position.

In the acid-amides the group which causes the abnormal behaviour may be either OH or NH, according as the formula $R.C(OH):N.R'$ or $R.CO.NH.R'$ is used; if the hydroxylic formula is correct o-nitrobenzanilid and benz-o-nitranilide should both be abnormal, whilst the keto-imide formula would make o-nitrobenzanilid abnormal and benz-o-nitranilid normal; experiment shows that all the substituted benzanilids behave abnormally, except those in which substitution takes place in the ortho-position in the aniline-group, thus confirming the ordinary keto-imide formula for the amides.

Imido-compounds are not abnormal when they possess a marked basic character; thus diphenylamine, methylaniline, and the imido-ethers behave normally when dissolved in benzene, but urethane gives very high values, and phenylurethane is also abnormal, though to a less degree. T. M. L.

677. *Gibbs' Phase-Rule.* **C. H. Wind.** (Zeitschr. Phys. Chem. 31. pp. 390–397, Dec. 22, 1899.)—The author remarks that the phase-law is generally given as a deduction resulting from a series of thermodynamical equations, but that it ought to be possible to give a simple and yet perfectly general proof of it based on general reasoning. He objects to the proofs given by Nernst and by Bancroft as being not really rigid. In the proof here given by himself the basis of the argument is the *existence* of the entropy function, not any particular analytical expression of the second law. F. G. D.

678. *Solidification of Mixtures of Two Substances.* **H. W. B. Roozeboom.** (Zeitschr. Phys. Chem. 30. pp. 385–412, Dec. 1, 1899.)—The author discusses the phenomena accompanying the solidification of a fused mixture of two substances under the following types:—

A. The mixture solidifies to a continuous series of mixed crystals of the same kind. (1) Solidification-points of all mixtures lie between those of the two constituents. (2) The solidification curve shows a maximum, or (3) a minimum.

B. The mixture solidifies to an interrupted series of mixed crystals of the same kind. (4) The solidification curve shows a transition-point, or (5) a eutectic-point.

C. The mixture solidifies to two kinds of crystals.

The first type represents the behaviour of mixtures of two substances which are completely isomorphous, but the author holds that the solidification curve can only be a straight line when the melting-points of the components are identical, and that this has only been observed experimentally in the case of optical isomerides, such as d- and l- camphoroxime, the melting-point curve of which is a horizontal straight line. Examples are also quoted from the experimental work of a large number of authors to illustrate the remaining types of mixtures. T. M. L.

679. *Transition-points of Mixed Crystals.* **H. W. B. Roozeboom.** (Zeitschr. Phys. Chem. 30. pp. 413–429, Dec. 1, 1899.)—A theoretical discussion of the transition-points of mixed crystals, classified into eight different types, similar to the discussion of the solidification-points in the preceding Abstract. T. M. L.

680. *Formation and Polymorphous Change of Mixed Crystals of Potassium and Thallium Nitrates.* **C. van Eyk.** (Zeitschr. Phys. Chem. 30. pp. 430–459, Dec. 1, 1899.)—A series of experiments undertaken in order to test the theoretical conclusions of the two preceding papers. Potassium nitrate melts at 339° and thallium nitrate at 206·1°; the solidification curve for mixtures of the two nitrates consists of two parts, the intersection of which corresponds to a eutectic-point, so that the mixture belongs to the fifth type described in Abstract No. 678 (1900). The temperature of the eutectic-point is 182°, and represents the solidification-point of a mixture containing 31·3 per cent. of KNO_3.

In order to determine the relationship between the composition of the melt and that of the crystals, a small quantity of the liquid was allowed to solidify in a special apparatus, in which the crystals could be separated and drained, and the thallium was then estimated by precipitation as thallium iodide. Mixtures containing more than 31·3 per cent. of potassium nitrate deposit crystals, which are richer in potassium nitrate than the liquid from which they separate, whilst mixtures containing less than 31·3 per cent. of KNO_3 deposit crystals richer in $TlNO_3$; since the former are lighter and the latter are heavier than the liquid from which they separate, the composition of the eutectic mixture (31·3 per cent. KNO_3) can be very accurately determined. By extrapolation it is found that the two types of crystals which separate together at the eutectic-point contain respectively 20 and 50 molecules per cent. of KNO_3; their densities should be 5·24 and 4·57, but the mixture is too intimate to allow of the separation of the crystals by any mechanical method.

If the whole of the liquid be allowed to solidify the nature of the phenomena will depend on whether the solid phase adjusts itself to the changing composition of the liquid phase or not; in practice, it appears that the crystals which first separate, and which are no longer in equilibrium with the liquid phase in its altered composition do, to some extent, redissolve, but that the adjustment of the solid phase to the altered conditions is only partial.

Potassium and thallium nitrates both crystallise in the rhombohedral system at high temperatures, but there is a gap in this "α" isomorphous series, since mixed crystals containing between 20 and 50 per cent. of KNO_3 are not formed at 182°. At ordinary temperatures the nitrates form a second "β" isomorphous series of rhombic crystals, but here also, as Fock has shown, there is a gap. The transition-point for potassium nitrate lies between 125 and 128°, and thallium nitrate was found to show a similar transition-point at 142·5°. The transition-point of each is lowered by the addition of a small quantity of the other nitrate, the lowest value of the transition-point being 133° on the side of the $TlNO_3$, and 108·5° on the side of the KNO_3; all these changes occur over a definite temperature interval. The conglomerates of crystals, which appear when the composition of the mixture lies outside the miscibility limits of the two substances, show two transition-points; if the series of mixed crystals richer in $TlNO_3$ be described as α (rhombohedral) and β (rhombic) and those richer in KNO_3 as α' and β', then at 133° the α crystals become unstable and break down into a conglomerate of β and α' crystals, which are then the stable forms, and at 108·5° the α' crystals break down similarly into a conglomerate of β and β' crystals.

The miscibility limits are as follows :—

(1) At the eutectic-point, 182°, $\alpha = 20\%$, $\alpha' = 50\%$ KNO_3.
(2) At the upper transition-point, 133°, $\beta = 20\%$, $\alpha' = 69\%$ KNO_3.
(3) At the lower transition-point, 108·5°, $\beta = 35\%$, $\beta' = 84\%$ KNO_3.
(4) At 25°, $\beta = 19\%$, $\beta' = 94\%$ KNO_3.
(5) At 10°, $\beta = 15{\cdot}5\%$, $\beta' = 96{\cdot}5\%$ KNO_3. T. M. L.

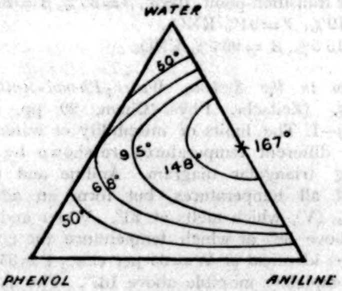
681. *Equilibrium in the System, Water-Phenol-Aniline.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem. 29. pp. 577–602, and 30. pp. 460–480, 1899.)—I. The limits of miscibility of water (W), aniline (A), and phenol (P) at different temperatures are shown by the isotherms in the accompanying triangular diagram. Aniline and phenol are completely miscible at all temperatures, but form an additive compound, $C_6H_5OH . C_6H_5NH_2$, (V), which melts at 31°. Water and phenol are completely miscible above 68°, at which temperature the composition of the two layers becomes identical at W = 65 per cent., P = 35 per cent. Water and aniline are completely miscible above 167°. The field in which two liquid phases appear is, in this case, continuous for each temperature, whereas in the system water-alcohol-succinonitrile two areas appear, the isothermals being in the form of two loops.

The addition of sodium chloride (6·47 per cent.) to a mixture of water and phenol, *raises* the miscibility limit from 68° to 143°, but the addition of alcohol (11·18 per cent.), which dissolves chiefly in the phenol and not in the watery layer, *lowers* the miscibility limit to 54·5°.

II. On cooling mixtures of water with aniline or phenol three cases are possible according as (1) each deposits ice, (2) each deposits solid aniline or phenol, (3) one deposits ice and the other deposits aniline or phenol. It is found by experiment that mixtures of water and phenol deposit solid phenol, but mixtures of water and aniline deposit ice ; the system therefore belongs to the third type, but is complicated by the fact that V may also separate as a solid phase.

Ice and aniline can exist together as two solid phases in contact with a single liquid phase at temperatures between —12° (eutectic-point for W and A, with no phenol in the liquid phase) to — 17°. Ice and phenol can exist as solid phases in contact with a single liquid phase under two sets of conditions: if the liquid phase consists chiefly of phenol the maximum temperature is —1·1°, whilst if the liquid phase consists chiefly of water the maximum temperature is — 0·9°, the eutectic-point for W and P. Similarly ice and V can exist together as solid phases up to — 0·9° in a mixture consisting chiefly of phenol, and up to — 0·5° in a mixture consisting chiefly of aniline ; in contrast to these limiting temperatures a genuine maximum temperature occurs for this system when P and A are present in molecular proportions ; this is the eutectic-point for W and V and occurs at — 0·3°, falling to a limiting temperature of — 0·5° or — 0·9° when aniline or phenol is added in excess of the proportions in which they combine to form V. Aniline and phenol as solid phases in contact with a single liquid phase have not been observed, but phenol and V, or aniline and V, may separate together at temperatures up to the eutectic-points, + 15° and — 11·7° respectively.

Two liquid phases can occur in contact with solid phenol from 1·5° (no aniline) to — 1·1° and in contact with ice from — 1·1° to — 0·9°, but solid aniline has never been observed experimentally in contact with two liquid phases. The maximum temperature at which the solid V can occur in contact with two liquid phases is 17·3° when aniline and phenol are in molecular proportions, falling to — 0·9° and 0·5° in presence of an excess of phenol or aniline respectively.



In mixtures of V with water there will be a definite transition-temperature (Uebergangstemperatur) at which alone the solid is in equilibrium with two liquid phases (1) if the compound V passes into solution unchanged, or (2) if it breaks up in solution, but the aniline and phenol are still in molecular proportions in each layer; in the latter case the effect on the transition-point of adding an excess of phenol or aniline will be represented by a continuous curve, since these are already present in the solution, but in the former case by two intersecting curves. If, however, the aniline and phenol produced by the dissociation of V are distributed unequally between the two liquid layers the transition-point will be broadened into a *transition-interval;* the solubility curve for the solid V in water indicates the presence of a narrow transition-interval from 16·9 to 17·2°. T. M. L.

682. *Equilibria in the System, Water-Ethyl Ether-Succinonitrile.* **F. A. H. Schreinemakers.** (Archives Néerlandaises, 3. pp. 1–78, 1899.)—The author, in continuation of his researches on phase-equilibria in which several liquid phases may coexist, describes in this paper a system in which *three* coexisting liquid phases make their appearance. The paper contains the experimental results, and a discussion of them by means of triangular diagrams and other graphical methods of representation. A theoretical treatment of the case of three coexistent liquid phases is postponed for a later paper. (See also 1898, Abstract No. 1261.) F. G. D.

683. *Dilutio Law.* **W. D. Bancroft.** (Zeitschr. Phys. Chem. 31. pp. 188–196, Dec. 22, 1899.)—The formulæ put forward by Ostwald (Zeitschr. Phys. Chem. 36, 1890) and by van't Hoff (*Ibid.* 18. 300, 1895) to

express the effect of dilution on the dissociation of weak and of strong electrolytes respectively are special cases of the formula $K = C_i^n / C_s$ (Storch, Zeitschr. Phys. Chem., 19. 13, 1896), where C_i and C_s represent the concentration of the ions of a binary electrolyte and of the undissociated salt respectively. Ostwald's formula ($n = 2$) gives good values in the case of weak acids and bases, whilst van't Hoff's formula ($n = 1{\cdot}5$) gives good values with "strong" electrolytes; it is now suggested that n should be determined empirically by plotting a curve with the values of log C_s as abscissæ and log C_i as ordinates; the curves are all straight lines, but deviate at high concentration, and in the case of concentrated solutions of KOH, HCl and LiCl maximum points occur; the inclination of the straight-line curve gives the value of n. Tables are given for 10 salts for which n varies from 1·36 (potassium chloride) to 1·55 (silver nitrate), and it is shown that the values of 100a (the percentage dissociation) calculated from the formula agree closely with the observed values up to a concentration approaching $C = 1$. It is suggested that the deviations in more concentrated solutions may be due in part to a variation of the migration velocity of the ions with the concentration, but may also be due to the conductivity ceasing to be a true measure of the degree of dissociation.

T. M. L.

684. *New Inorganic Ionising Solvent.* **P. Walden.** (Ber., 32. pp. 2862–2871, Nov., 1899.)—Liquid sulphur dioxide dissolves a number of inorganic salts, as well as hydrocarbons, alcohols, organic acids, esters and bases. Many of the solutions show characteristic colours, and double decompositions and colour-reactions take place as readily as in aqueous solutions. Conductivity measurements are given for solutions, in liquid sulphur dioxide at 0°, of potassium, sodium, ammonium and rubidium iodides, potassium bromide, potassium and ammonium thiocyanates, trimethylsulphine iodide, tetramethyl and tetraethylammonium iodides; in the case of the last three substances the values for the conductivity were considerably greater that those for similar solutions in water at 0°. Molecular weight determinations made by Landsberger and Walker's method showed that potassium, sodium, rubidium and ammonium iodides are polymerised in solution in sulphur dioxide, but potassium thiocyanate, trimethylsulphine iodide, tetramethyl- and tetraethylammonium iodides appear to be dissociated to a very considerable extent. The molecular elevation of the boiling-point was calculated from the boiling-point and latent heat of fusion to be 15·02, whilst an experimental determination with non-electrolytic solutions of naphthalene, toluene, and acetanilid gave $E = 15{\cdot}0$.

T. M. L.

685. *Electrolytic Conductivity of Non-Aqueous Solutions.* **A. T. Lincoln.** (Journ. Phys. Chem. 3. pp. 457–494, 1899. From the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters, vol. 12. pp. 395–453.)—This is practically a continuation of the paper referred to in Abstract No. 731 (1899). Qualitative and quantitative measurements were made with a large number of organic solvents. A great part of the paper is filled with a discussion of the work of other observers, and should prove useful as a bibliographical review.

W. R. C.

686. *Ionisation of Salts in Methyl and Ethyl Alcohols.* **H. C. Jones.** (Zeitschr. Phys. Chem. 31. pp. 114–141, Dec. 22, 1899.)—The method employed consists in determining the rise of boiling-point. The author uses an apparatus for which he claims that it reduces radiation errors to a

minimum, prevents the cold condensed solvent from coming into contact with the thermometer, and renders a vapour-mantle unnecessary. The salts investigated in methyl alcohol are the iodides and bromides of potassium, sodium and ammonium, potassium and sodium acetates and calcium nitrate. For the halides the calculated dissociations run from 47 to 64 per cent. For the acetates the value is about 88 per cent., while for calcium nitrate it is about 14 per cent. The salts investigated in ethyl alcohol are the iodides of potassium and sodium, the bromides of sodium and ammonium, potassium and sodium acetates, and calcium nitrate. The dissociations are here much smaller than in the case of methyl alcohol. (See also 1898, Abstract No. 1378.)
F. G. D.

687. *Influence of Substances Containing a Common Ion on the E.M.F of Concentration Cells and on the Velocity of Diffusion.* **R. Abegg** and **E. Bose.** (Zeitschr. Phys. Chem. 30. pp. 545-555, Dec. 1, 1899. From the Jahresbericht der Schlesischen Gesellschaft für Vaterländische Kultur.)—Employing Nernst's theory it is shown that the E.M.F. of a liquid cell containing two solutions of different concentrations of an electrolyte KA will be diminished by the addition of an electrolyte K'A in equal concentration on both sides.

Proceeding to electrolytic diffusion the authors show that an electrolyte will diffuse with a velocity corresponding to the mobility of its anion or its kation, according as the solution (through addition of another electrolyte) contains a great excess of the kation or anion respectively. On this result they base a hypothetical explanation of the influence exerted by neutral salts in increasing the catalytic action of hydrogen ions, as observed by Arrhenius in the inversion of sugar.
F. G. D.

688. *E.M.F. of Cells and Thermo-Chemical Data.* **D. Tommasi.** (Elect. Rev. 45. pp. 1063-1064, Dec. 29, 1899.)—The author enunciates the law that when one metal replaces another in a saline solution the heat evolved for a given metal is the same (called the thermic constant) whatever the nature of the acid radicle. Hence the E.M.F. of a cell of the Daniell type is independent of the electrolytes. Examples are given of the calculation of E.M.F. of two-fluid cells. In the case of one-fluid cells the E.M.F. is given by the difference of the thermic constants of the metal dissolved and of the hydrogen evolved.
W. R. C.

689. *E.M.F. and Chemical Equilibrium.* **V. Rothmund.** (Zeitschr. Phys. Chem. 31. pp. 69-78, Dec. 22, 1899.)—Van't Hoff's well-known equation—

$$E = RT \log k$$

(where k is the reaction constant) is applicable in many cases where the reaction is not directly an electrochemical one. Thus the reversible dissociation of a metallic oxide, say—

$$HgO \rightleftarrows Hg + O$$

can be brought under it by measuring the E.M.F of the cell—

$$Pt : O_2 : \text{normal } NaOH : HgO : Hg.$$

By means of a cyclic process of thermodynamics the author shows that—

$$E = \frac{RT}{4f} \log p$$

where p is the dissociation pressure, and f = quantity of electricity associated with 1 gram-equivalent. For mercuric oxide this gives $p = 10^{-10.96}$ atmos. Accordingly mercury should oxidise in air at ordinary temperature: that it does not in practice may be set down to excessive slowness of reaction, or to a "false equilibrium"; the numerical result does not, however, agree with those of Pélabon for high temperatures. Other cases are considered similarly, but without numerical results. R. A. L.

690. *Electrolytic Reduction of Potassium Chlorate.* **A. L. Voege.** (Journ. Phys. Chem. 3. pp. 577–601, Dec., 1899.)—In order to obtain data which may serve as a basis for a theory of electrolytic reduction, an exhaustive quantitative study has been made of the reduction of potassium chlorate, this salt being chosen on account of the ease with which it and its reduction products can be analytically determined, and also because the total yield varies much with changing conditions. The author draws the following conclusions from the experimental results, full details of which are given in the paper. (1) The reduction is greater in acid than in alkaline solutions. (2) The amount of reduction varies with the metal used for the electrodes, zinc being more efficient than cadmium, and the latter more so than platinum. (3) With zinc and platinum the reduction increases greatly with decreasing current density, whilst this is not observed with cadmium. (4) The reduction yield is greatly affected by the physical structure of zinc electrodes, large crystals being associated with a higher efficiency. (5) An increase of temperature greatly facilitates reduction. (6) The reduction depends largely on the strength of the sulphuric acid used, the maximum efficiency being obtained with about 1·5 normal strength. (7) Decreasing the current strength increases reduction, but this result is possibly due to the change in voltage occurring. (8) No electrolytic reduction occurs at the anode in zinc, cadmium, and platinum cells, all chloride found there being due to the action of the acid and to diffusion from the kathode cell. (9) Potassium zincate is formed at the kathode by the secondary reaction of potassium hydroxide, electrolytically formed, with the zinc, and the hydrogen resulting from this reaction is used in reduction, making it possible to obtain an electrolytic efficiency of more than 100 per cent. (10) Copper is only slightly attacked by sulphuric acid alone, but is readily dissolved in the presence of potassium chlorate, and an almost quantitative yield of potassium chloride is obtained. (11) This reduction by copper without electrolysis is about four times that by zinc for equivalent quantities dissolved, although zinc dissolves much more slowly than copper. (12) With copper electrodes the electrolytic reduction is probably less than with zinc electrodes, but this is difficult to establish conclusively because of the great amount of reduction due to purely chemical causes when copper is employed. N. L.

691. *Electrolysis of Potassium Chloride.* **A. Brochet.** (Comptes Rendus, 130. pp. 134–137, Jan. 15, 1900.)—A series of experiments on the lines of those described by Foerster (see 1899, Abstract No. 1946) was made, reduction being entirely prevented by the addition of potassium bichromate, as recommended by Müller (see 1899, Abstract No. 1408). In one of the experiments, the results of which are represented by curves, a solution containing 20 per cent. of potassium chloride, 0·1 per cent. of potassium bichromate, and 0·2 per cent. of caustic potash was electrolysed at 16°–20° between platiniridium electrodes, using a current density of 0·045 ampere per square centimetre at 3·4–3·85 volts. In the first 1½ hours the total current efficiency fell from 98

to 90 per cent., and in the same time the amount of hypochlorite attained its constant value, equivalent to about 15 grammes of chlorine per litre. The proportion of chlorate formed increases very slowly during the time that hypochlorite is produced, but afterwards increases rapidly and uniformly until it becomes constant. The electrolysis of water, very slight at first, gradually increases and becomes constant at the end of three hours. Without alkali the current yield is still higher and more hypochlorite is formed, whilst if more alkali is added the yield, and the production of hypochlorite, decrease. The yield of potassium chlorate is over 70 per cent., whereas without the addition of chromate not more than 35 per cent. is obtained. N. L.

692. *Electro-deposition of Zinc.* **S. Cowper-Coles.** (Electrician, 44. p. 434, Jan. 19, 1900.)—The experiments described by the author were undertaken in order to determine the adhesiveness of zinc to steel, when deposited under varying conditions as regards preparation of the steel plates, acidity of the electrolyte, and current strength. It was found that perfect adhesion was only secured when the current was reversed for a few moments before commencing the deposition. In other cases the deposit was non-adhesive, a result ascribed by the author to the slight film of oxide which covered the steel. Neutral solutions were found to yield the most regular and even deposits. J. B. C. K.

693. *Merits of Finely and Coarsely Powdered Materials in Manufacture of Calcium Carbide.* **B. Carlson.** (Zeitschr. Elektrochem. 6. pp. 324–328, Dec. 7, 1899.)—The author fully discusses the respective merits of coarsely and finely powdered raw materials in the manufacture of calcium carbide, and expresses his opinion as to the advantage of a coarse mixture. The heat necessary for obtaining the carbide is partly utilised in heating and melting the raw materials, *i.e.*, carbon and lime. Neither the specific nor the melting heat of these two bodies is affected by the size of the grains employed. A number of proofs in favour of a coarse mixture are given, such as the solubility of the raw materials in the already formed carbide, and the greater ease with which the gases formed can find their exit without giving rise to explosive eruptions, as in the case of a dense mixture, and the accompanying throwing up of fine dust, &c. Another important point seems to consist in the better utilisation of the heat of the gases generated in their upward passage and also the prevention of bridging over of the molten particles.

The theoretical quantity of lime and coke together for the production of 1,000 kilos of carbide equals 1,440 kilos. Actual trials by the Deutsche Gold and Silber Scheideaustalt in Frankfort have shown that 1,590 kilos are required in practice with the coarser mixture there employed. In the case of fine material 3,000 kilos and upwards are required. The process used at the above works is the one introduced by J. Pfleger for employing coarse mixtures, and has some novel features which the author promises to discuss in a future communication. O. J. S.

694. *Cost of Calcium Carbide.* **H. Allen.** (Elect. Rev. 46. pp. 7–8, Jan. 5, 1900.)—The author bases the estimates given in these notes upon theoretical data, and upon the lowest realised cost for electrical energy when derived from water-power, namely, 0·131d. per B.T.U. Using these figures, he estimates that one ton of carbide should cost £9 5s. 5d. The details of his estimate are as follows :—

	£	s.	d.
2·143 tons Limestone at 10s. (crushed)	1	1	5
0·80 ton Coke at 20s. (crushed)	0	16	0
4374 B.T.U. at 0·131d.	2	11	8
Electrode Carbons	1	0	0
Labour, Oil, Waste, Interest and Maintenance Charges	3	16	4
	£9	5	5

The author states that this result can be improved upon by use of blast-furnace gases for power generation by the Thwaite-Gardner or other system, and reference is made to the installation of the former for carbide production at an ironworks in Westphalia. J. B. C. K.

695. *Ducasse Electric Furnace.* (Ind. Électrochim. 3. pp. 116–117, Nov., 1899. From the *Ingénieur français* through *Electro-chimie,* 1899, p. 174.)—The furnace is circular in plan with a movable hearth, the whole of which acts as the negative electrode. A tap-hole is provided to run off liquid smelting-products, and in the upper portion of the furnace is a side flue, provided with a sight-hole and cleansing door; through this flue the heated furnace gases are carried to a chamber in which the furnace-charge is pre-heated. The furnace is surmounted with a domed cover fitted with an eye-bolt by which it may be raised from its position, and perforated with charging doors, and with four apertures, through each of which passes one of four carbon rods forming the positive electrodes. These electrodes are supported from above in such a way that their position may be regulated automatically or at will. By means of a motor working on a shunt from the main circuit, a rotary current-distributor causes the main current to pass through each of the electrodes in succession 3,000 times a minute, contact with any one carbon not being broken until that with the next has been made, so that sparking is avoided. There is in this way produced in the hearth of the furnace an arc which practically rotates at 3,000 revolutions per minute. W. G. M.

REFERENCES.

696. *Electromotive Behaviour of Chromium.* **W. Hittorf.** (Zeitschr. Phys. Chem. 30. pp. 482–507, Dec. 1, 1899.)—Details of paper previously noticed. (See 1899, Abstract No. 1744.) N. L.

697. *Electro-Galvanising, Notes on.* **S. Cowper-Coles.** (Indus. and Iron, 28. pp. 69–70, Feb. 2, 1900.)—A paper similar to those referred to in Abstracts Nos. 490 (1899), 286 and 548 (1900). J. B. C. K.

STEAM PLANT, GAS AND OIL ENGINES.

698. *Receiver Drop in Multiple Expansion Engines.* **R. L. Weighton.** (Mech. Eng. 5. pp. 124–127, Jan. 27, 1900. Abstract of paper read before the North-East Coast Institution of Engineers and Shipbuilders, at Newcastle-upon-Tyne, Jan. 19.)—The author gives results of trials to determine the most economical point of cut-off in the larger cylinders of multiple expansion engines. The deductions from the results of the trials are :—

(1) $$\frac{\text{Maximum-economy cut-off}}{\text{Stroke}} = \frac{R + 6{\cdot}6}{6{\cdot}6\,R}$$

where R = the ratio between the capacities of the given cylinder and the preceding cylinder.

(2) If maximum economy at all powers is to be preserved, the cut-off in larger cylinders, once fixed, should never be altered, whatever may be the cut-off in the H.P. cylinder, or the steam pressure.

(3) The cut-off of maximum power coincides with the cut-off of maximum economy in L.P. cylinder of triples, and the second intermediate and L.P. cylinders of quadruples. The maximum-power cut off is considerably later than that of maximum economy in second cylinder of triples and quadruples. In compounds the maximum-power cut-off in the L.P. cylinder is only slightly later than that of maximum economy.

(4) When R is from 2 to 2·5 the cut-off in larger cylinders may be varied considerably without an appreciable fall in economy, but where R is large, deviation entails a fall in economy.

(5) With given efficiency in receiver drop, smallness of cylinder ratio is conducive to smoothness of working, uniformity of turning, durability, handiness in starting and reversing, and compactness of design. J. T. R.

699. *Friction Tests of a Locomotive Slide Valve.* **F. C. Wagner.** (Mech. Eng. 4. pp. 857–858, Dec. 9, 1899. Paper read before the American Society of Mechanical Engineers, Dec., 1899.)—During some recent locomotive tests made at the Rise Polytechnic Institute by Butler and Crebs it was found desirable to operate one of the valves by an electric motor. It occurred to the writer that some useful data upon the friction of a locomotive slide valve might easily be obtained. The power used to drive the valve was obtained by measuring that delivered to the motor, and making allowances for the efficiency of the motor and the friction of the transmitting mechanism. Two tests were made, and the results are given in tabular form; in one trial the coefficient of friction was 0·050, in the other trial 0·036. A. S.

700. *Friction of Steam Packings.* **C. H. Benjamin.** (Mech. Eng. 4. pp. 838–839, Dec. 9, 1899. Paper read before the American Society of Mechanical Engineers, Dec., 1899.)—The experiments described in this paper were made at the Case School by senior students under the direction of the writer. The apparatus consists of a cast-iron cylinder 6 × 13 inches inside, fitted at each

end with a cover and stuffing-box suitable for a 2-inch rod. The rod was given a reciprocating motion by means of a slotted cross-head and crank, a pulley on the crank was connected by a belt with a transmission dynamometer, steam was admitted to the cylinder, and the condensed water drained off from time to time. The travel of the rod was 4·25 inches, and the usual speed about 200 revolutions per minute, giving a piston speed of 140 feet per minute. Seventeen different varieties of packing were tested, none being metallic packings strictly so called. The apparatus was first tested empty to determine the friction, the packing was then inserted and adjusted, and the steam turned on. The very least pressure which would prevent leakage was used on the gland nuts. The packing was then tested under steam pressures, each run lasting from 15 to 40 minutes. The results are given in a table, and the effects of varying steam pressure and of tightening the gland nuts are discussed.

The following general conclusions are drawn: (1) the softer rubber and graphite packings, which are self-adjusting and self-lubricating, consume less power than the harder varieties. (2) Oiling the rod reduces the friction with any packing. (3) There is almost no limit to the loss caused by the injudicious use of the spanner. (4) The loss of power varies almost directly with the steam pressure in the harder varieties of packing, but is nearly constant with the softer kinds. A. S.

701. *Packing Ring for Piston Valves.* (Mech. Eng. 4. p. 752, Nov. 18, 1899.)—A description of a packing ring for piston valves for a heavy freight locomotive built for the Illinois Central Railroad by the Brooks Locomotive Works. The packing ring is made in one solid piece, and turned up of larger diameter than the bore of the bushing. A saw-cut is made on the bevel across the ring and a shim of the required thickness is inserted. The ends are then clamped together by a bolt, lugs for the purpose being provided on the inside of the ring, and accurately turned to the proper size. The design seems to have the advantage of a plain plug valve and an additional one, in that the valve may at any time be made tight with comparatively little expense. A. S.

702. *Water-tube Boilers in the U.S. Navy.* **G. W. Melville.** (Mech. Eng. 4. pp. 897–899, Dec. 16, 1899. Abstract of paper read before the Society of Naval Architects and Marine Engineers, New York, Nov., 1899.)—The adoption of water-tube boilers in all future vessels of the U.S. Navy is a natural step in the advance towards a perfect naval fighting machine. The engineer-in-chief of that navy considers that the design of these boilers is wrong in principle on account of the pressure being inside, instead of on the outside, of the tubes, these being the weakest part of the boilers; also on account of the smaller quantity of water in the boiler, the difficulty of observing a leak, and the decreased value of the heating surface. Nevertheless these boilers are tactical necessities for warships. They are considerably lighter than boilers of the old type, and in consequence the ship having them will be smaller and handier—will have somewhat less draught, and will cost less. The draught of water is the limiting condition in size of warships, so that for a maximum of fighting efficiency water-tube boilers must be used. Any saving of weight or space consistent with efficiency is of great importance in war vessels.

All torpedo boats and destroyers in the American navy since the *Cushing* have been equipped with water-tube boilers, which have proved to be quite as reliable as the light engines used in these boats, and by making the attainment of higher speeds possible have added to their efficiency and security.

The water-tube boilers in the *Monterey*, the *Nashville*, the *Marietta*, the *Annapolis*, and the *Chicago*, of different designs, have come successfully through a number of trials—the *Monterey* having made a voyage of about 8,000 knots, largely under forced combustion, and whenever possible with all boilers in use, and the *Marietta* having made a trip round South America, with marked success in the performance of these boilers.

The re-tubing of these boilers has been accomplished on board by the engineering staff of the vessel, without the necessity of laying up the ship at a navy yard, and the parts of new boilers have been assembled and erected in position without disturbing the decks. In the case of vessels having protective decks, the latter is a result of enormous importance, and one impossible with cylindrical boilers.

Particular attention must be given to the feed arrangements with water-tube boilers—the feed pumps must be ample and the regulation easy. The heating surface, which was at first 3 square feet per H.P., as against 2 square feet, necessary with cylindrical boilers, is now 2·4 square feet. The ratio of heating to grate surface is kept up to 40, the grates being larger than those of cylindrical boilers. The increased grate surface obtained with water-tube boilers is an improvement, giving power of sustained sea speed. No trouble has been experienced from salt water or grease in these boilers, but in the short naval war with Spain the U.S. war vessels suffered severely from dropped furnaces in cylindrical boilers. With regard to the accidents and failures reported against water-tube boilers, the author remarks that we hear of all the failures but the successes are never mentioned. He considers that the experience of the last ten years or more in the U.S. and other navies proves that water-tube boilers, when proper precautions are used, can be successfully adopted for the steam-generating plant of ocean-going vessels. A number of warships are being fitted with water-tube boilers. The paper concludes with a summary of the advantages and disadvantages of these boilers which have been discussed. F. J. R.

703. *Accidents to Water-tube Boilers and their Remedies.* **A. Ravier.** (Écl. Électr. 21. pp. 427–429, Dec. 16, 1899. Paper read before the Assoc. Française, at Boulogne.)—The causes of accidents to water-tube boilers have been classified, according to the following table, from statistics collected (in France) for the years 1890–1897. In this table E indicates that the cause was exclusive, and C that it was combined with some other cause.

I. Splitting of the tubes.	E	C
1. From formation of scale in the tubes	8	9
2. „ abnormal fall of the water-level	12	1
3. „ worn-out tubes	4	2
4. „ defective manufacture	3	3
5. „ muddy deposits due to bad circulation	5	1
6. „ forcing the boiler	2	4
Total of accidents from known causes	34	20[1]
7. „ unknown causes	8	
II. Other accidents	11	

[1] Ten of these with rupture of the tubes.

Out of 78 accidents, 52 were due to rupture of the tubes, and in the case of 48 of these the exact positions of the tubes in the boilers were as follows:—

Tubes in the bottom rows	17
„ second and third rows from the botttom	6
„ intermediate rows	18
„ top rows	7
	48

To prevent scale, the only sure method is to have pure water. Otherwise an active circulation must be maintained in the tubes immediately over the fire (which tubes should not be less than 2 inches in diameter); the feed should be delivered in the steam space; all grease should be separated from the condensed steam, and the boiler should be frequently cleaned.

The boiler may be emptied for cleaning either when hot and under steam pressure or when nearly cold. The first method is the more rapid, but frequently causes hard deposits which must be removed by hammer and chisel at the risk of damage to the boiler. The second, though slower, gives rise to muddy deposits which are easily washed out, and therefore it is recommended.

Attentive supervision is the remedy for lowering of the water-level, and the wear of the tubes can be greatly prevented by having them made of nickel steel, containing 25 per cent. of nickel.

In order to confine the effects of ruptured tubes to the smallest possible limits, an automatic tube stopper has been designed by A. Janet for horizontal tubes, which remains at an angle permitting the proper action of circulation in the boiler as long as the currents are flowing in the normal directions, but is quickly forced up into the mouth of the tube when there is a rush of water towards a leak. The pressure in the boiler then holds the stopper in position, and the escape of water and steam is prevented. F. J. R.

704. *Influence of Velocity on Evaporation in Tubes.* **G. Halliday.** (Engineer, 88. p. 653, Dec. 29, 1899. Paper read before the Institute of Marine Engineers.) This is the author's second paper on the heat-absorbing power of water in motion. In his first one (Engineer, 87. p. 473. See 1900, Abstract No. 83), he showed, generally, that up to a certain point, when the source of heat is kept constant, and the difference of temperature between the outflowing hot and the inflowing cold water is about 150° F., the number of thermal units which the water absorbs per minute increases steadily with the speed of flow. This effect is not greatly altered even when the water is heated up to boiling-point, but the rate of absorption is less at that point than at 10° below it. With the apparatus then used, in which superheated steam was caused to heat the water flowing through a spiral glass tube immersed in the steam, there seemed to be a critical point in the velocity beyond which the thermal absorption fell away, sometimes very rapidly. That, however, was due to the heating powers of the apparatus being too limited to cope with the requirements of the water at the higher velocities employed.

In the present paper the author records experiments made with modified apparatus to test the rate of heat transmission with water which is freely giving off steam and is also made to flow through the apparatus at increasing velocities. The former experiments stopped at the boiling-point, so that the effect of a mixture of steam and water was not present in them. In this new series the water, previously heated to boiling-point in a tank, is made to flow upwards through a vertical copper tube heated by a Fletcher gas burner, the mixture of steam and water passing into a separator, from which the water goes to a measuring flask and the steam through a condenser to a graduated measure. The velocity of the water flowing through the heated tube, and the quantity of water evaporated, are expressed in cubic centimetres per 4 minutes—each experiment having been continued for that period. With a moderate flame at the Fletcher burner, kept constant, and varying rates of flow of water, the following are some results :—

Velocity of Water.	Evaporation.
54½ c.c. per 4 minutes	24½
93 " "	23
122 " "	22
378 " "	18
575 " "	15
664 " "	14
762 " "	12

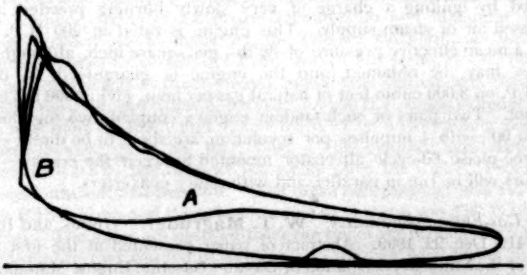
The character of the curves formed by plotting the results in various instances is practically the same, a larger amount of heat merely forming a curve at a higher level. The author observes that (with the small tube used in these experiments), a velocity which gives an evaporation about equal to the quantity not evaporated seems to give the best result.

The author concludes that whilst the quantity of steam evaporated depends on the quantity of heat supplied to the tube, and on the velocity of the water through the tube, yet the greater the speed of the water through the tubes of a water-tube boiler the less will be the evaporation. F. J. R.

705. *Corrosion and Cracks in Locomotive Boilers.* **Desgeans.** (Mech. Eng. 4. pp. 731–735, Nov. 18, 1899. From the Revue Générale des Chemins de Fer ; also the Railroad Gazette.)—The author gives a summarised statement of various defects, such as pitting, grooving and cracks, which are found in locomotive boilers at work, and lead to failure of the boiler or necessitate repairs. The defects are ascribed either to chemical or to mechanical action, or to a combination of both, without entering into any elaboration of the course of such action, except to a small extent in the case of some of the mechanical stresses. Some practical observations on points to be observed in construction and working conclude the paper. F. J. R.

706. *Gas Engines.* **J. Dunlop.** (Mech. Eng. 4. pp. 739–742, Nov. 18, and pp. 766–768, Nov. 25, 1899.)—This paper, read before the Owens College Engineering Society on November 14, 1899, gives the results of an investigation of the troubles experienced with a large gas engine of the high-speed single-acting type, working on the common four-stroke, or "Beau de Rochas," cycle. The usual positions of the crank are shown when the valves are timed to open and close ; also the valve setting of the Crossley scavenging engine, by which it was attempted to utilise the wave action of the exhaust for clearing the burnt products out of the cylinder. Here the air and exhaust valves were open together during the latter part of the exhaust stroke, and the early part of the suction stroke until the exhaust valve was closed later than usual. The economy effected was found to be almost entirely due to an increase in the compression pressure of the engine, and not to the

"scavenging." A Crossley scavenging engine cylinder 18¼ inches in diameter by 24 inches stroke was required to develop at 200 revolutions per minute a maximum of 102 B.H.P. for two hours on Dowson gas. To do this it was necessary to maintain, during every possible power stroke, a mean pressure of 75 lbs. per square inch. The engine had only been running a few minutes on trial when explosions in the air pipe began to take place alternately with bumping noises in the cylinder. Indicator diagrams, as shown in the figure, were taken to locate these troubles. The small loop above the atmospheric line is the indication of an explosion in the air pipe during the suction stroke. Consequently during the next power stroke A, the charge of burnt gases only smoulders instead of burning quickly. Light spring diagrams show that the explosions in the air pipe took place at all parts of the suction stroke, and that, owing to the exhaust valve being open during part of the suction stroke, a portion of the hot smouldering exhaust products was drawn into the cylinder. This would also account for pre-ignition, indicated at B, which produces the knocking in the cylinder. In the case of an engine having an ignition timing valve, this pre-ignition is mostly caused by overheated metal in the cylinder igniting the charge of air and gas, under compression. After the engine had been running twenty minutes, explosions in the air pipe and pre-ignition became almost continuous, and, with the ordinary ignition apparatus out of action, continued for a time to ignite the charges automatically. Although the load was eased the engine pulled up at the end of about half an hour, when the exhaust valve was seen to be a dull red heat, and small pieces of wood laid on the top of the valve took fire immediately. This was remedied by making the exhaust valve hollow for cold-air circulation in the interior of the valve. The writer's contention is that in this scavenging engine the valve-setting was the cause of nearly all the trouble.



When a run was made with the normal valve-setting, the engine acted quite satisfactorily. The mean pressure throughout the stroke was 85 lbs. per square inch with coal gas. A simple and reliable scavenging arrangement, like that in the Premier gas engine, is desirable, especially for engines using Dowson or similar fuel gas.

W. R.

707. *Standard Automatic Gas Engine.* (Amer. Electn. 11. pp. 578–579, Dec., 1899.)—The novel feature of the Raymond horizontal gas engine is the valve gear. The one valve, for both admission and exhaust, is a hollow cylinder of cast iron, chilled and ground. As it rotates in the valve chest a port connects the interior of the valve—which is open to the cylinder—

alternately with the admission and exhaust chambers. Ignition is electrical by wiping spark between wide tool-steel electrodes, and the moving contact simply rotates with the valve. Governing is by varying the quantity of the charge, which is throttled by one plain balanced butterfly valve. The proportions of the mixture are determined by valves in the air and gas pipes. Small engines are of the ordinary single-acting form on the Beau de Rochas, or four-stroke cycle. Sizes of 50 H.P. and upward have two tandem single-acting cylinders, with the compression stroke in one following the expansion stroke in the other, giving one impulse every revolution. One long piston-rod runs through the ends of both cylinders, with non-inflammable packing, and is made hollow for the circulation of cooling water.

The large engine has two double-acting cylinders in tandem on one piston-rod with outside cross-head of steam engine construction (like the tandem Griffin double-acting engines at Belfast electric lighting station). The piston-rod is made of nickel steel, drawn with the hole for cooling water, which also passes through the inside of the pistons. One horizontal shaft turns the four hollow cylinder valves for the four ends of the engine cylinders. The engine is started by igniting a charge of very slowly burning powder, also by compressed air or steam supply. This engine is rated at 200 H.P. on the basis of a mean effective pressure of 32 lbs. per square inch, although higher pressures may be obtained, and the engine is guaranteed to develop 300 B.H.P. on 3,000 cubic feet of natural gas per hour, giving 990 B.Th.U. per cubic foot. Two pairs of such tandem engines coupled two together with cranks at 90°, with 4 impulses per revolution, are about to be direct coupled to a three-phase 60-cycle alternator mounted between the cranks. These alternators will be run in parallel, and with rotary converters. W. R.

708. *Gas-Engine Guarantees.* **W. T. Magruder.** (Indus. and Iron, 27. pp. 411–412, Dec. 22, 1899. Abstract of paper presented at the first annual meeting of the National Association of Gas and Gasoline Engine Manufacturers of the United States.)—*Power.*—Some gas engine catalogues fail to distinguish between nominal, indicated, and actual horse-powers. The variation in indicator diagrams, from a gas engine having either a throttling or hit-and-miss governor and a load which varies, prevents greater accuracy than 90 to 95 per cent. in the measurement of the indicated H.P. The continuous indicator is not yet a practical success.

The friction of the engine may use up 10 to 35 per cent. of the work done on the piston. The chief value of the ordinary gas-engine indicator is to show faulty setting of valves, excessive back pressure of exhaust, and obstruction in gas and air inlets. Engines should be sold by the actual power delivered at the belt pulley or crank-shaft, which can be easily measured by a brake.

The accurate *regulation of speed* of gas engines is necessitated by the effects on electric lamps, and the fluctuation is reduced by the kinetic energy of heavy fly-wheels. Guarantees are given in catalogues of gas-engine makers of the variation of speed being only 1 and 1½ per cent., while one claims to run his engine at "an absolutely uniform speed, which may be varied instantly from 50 to 600 revolutions per minute;" but the writer has never seen any steam engine which regulated as badly as some gas engines.

It is essential in making guarantees as to *cost of running* not only to know the cost per cubic foot of gas or per gallon of oil, but also the calorific value of that fuel per cubic foot, per lb. or per gallon, at standard temperature and pressure, knowing the specific gravity, as well as other physical properties of the fuel.

Consumption of fuel will vary with the calorific value, and the best proportion of air, also with the size of air valves, passages, and pipes. Other things being equal, the volume of gas used will vary with the pressure and temperature of both the gas and air. A gas engine should be guaranteed to give a H.P. on a given number of heat units with a given fuel. The day has passed when gas-engine guarantees can be made, accepted, and paid for, on "so many feet of gas per H.P.," and nothing more. W. R.

709. *High-Furnace Gases for Power.* **B. Donkin.** (Engineer, 88. pp. 509–510, Nov. 24; 561–562, Dec. 8; 588–590, Dec. 15, 1899.)—These articles give a description and general plans of some large gas engines adapted to use high-furnace gases. The Oechelhaueser gas engine, with two pistons working in opposite directions in one cylinder, is similar to the Atkinson "Differential." At the Hörde Ironworks in Westphalia a 600 H.P. Oechelhaueser motor, made by the Deutsche-Kraft Gesselschaft, consists of two single-cylinder engines each of 300 H.P. at 135 r.p.m. Each cylinder is 19 inches diameter, and 31·5 inches stroke with pistons. A 1,000 H.P. engine of this type, with two cylinders and four pistons, is being erected at Fishershütte, near Hanover.

The Simplex engine of Delamare-Deboutteville and Malandin to work with high-furnace gas is made by the Société Cockerill, at Seraing, in Belgium (see *Revue Universelle des Mines*, vol. 43, 3rd series, p. 113, 1898). In December, 1895, a 4 H.P. experimental engine was started with these waste gases, and was improved to develop 8 H.P. A 200 H.P. single cylinder simplex engine was built in 1897; and tested by Witz on a twenty-four hours' run with blast-furnace gases in July, 1898. The cylinder was 31·5 inches diameter, stroke 3·28 feet, and at 105 r.p.m. gave 181 B.H.P. (French) with mechanical efficiency 85 per cent. The mean consumption was 117·5 cubic feet per B.H.P. hour, and the calorific value of the gas was 110 B.Th.U. per cubic foot. The gases are induced from the top of the furnaces by a Koerting steam-jet and further washed in scrubbers to remove part of the dust; and the charge is compressed in the engine cylinder to 8 atmospheres before ignition by electric spark. Two or three grammes of metallic dust per cubic meter of gas are carried into the cylinder and pass out with the exhaust, equal to 88 lbs. daily for the 200 H.P. engine, which has been working satisfactorily for eighteen months. For simplex engines, each of 550 B.H.P. having single cylinder of diameter 4 ft. 3 in., stroke 4 ft. 7 in., with Riedler valves, are being constructed to drive the blowers direct.

In Germany the Gas Motoren Fabrik, Deutz, make ordinary Otto cycle engines of two cylinders, on opposite sides of crank, up to about 250 B.H.P per cylinder—thus a 500 H.P. plant has two and a 1,000 H.P. four cylinders. At Oberhausen the furnace gases are cleaned by passing through three coke scrubbers and four purifiers with small coke, but no water is used. In October, 1898, Meyer tested a 60 H.P. Otto motor driven with high-furnace gas (see particulars in *Zeitschrift des Vercines deutscher Ingenieure* vol. 43, No. 16, p. 453). The engine indicated 79·5 H.P. and the B.H.P. was 65·3 with a consumption of 96·7 cubic feet of gas B.H.P. hour. The heating value of the gas in the colorimeter was 105 B.Th.U. per cubic foot, and the heat turned into indicated work 30·2 per cent. These results are better than those obtained in ordinary practice. In England the work done hitherto with high-furnace gases has been chiefly experimental. At the Glasgow Ironworks, Wishaw, a 30 H.P. Acme gas engine, started in 1895, and the consumption is 95 cubic feet of high-furnace gas per B.H.P. hour. The furnace is fed with Scotch splint coal, and the waste gases have a heating value of 98 B.Th.U.

per cubic foot. The engine, tested by Booth while driving a dynamo, gave 1 E.H.P. hour per 1½ lb. of coal fed into the furnace, and consumed about 140 cubic feet of gas per E.H.P. hour. A plant of 160 H.P. has been working at Barrow-in-Furness.

Plans are given of a 530 H.P. two cylinder motor, built by Crossley for producer gas; also of a 250 B.H.P. Stockport gas engine to work with coke-oven gas; and of a Premier single cylinder gas engine of 250 B.H.P., the first large power engine built to utilise high-furnace gases in England. (See 1900, Abstract No. 297; also in 1898, Nos. 991, 992, and 993.) W. R.

REFERENCES.

710. *Stresses in Steam Engines, with Special Reference to Electric Traction.* (Elect. Rev. 45. pp. 375–376, and p. 458, 1899.)

711. *Influence of Electrical Developments upon Steam Engineering.* **W. Ripper.** (Mech. Eng. 4. pp. 770–772, Nov. 25, 1899. A lecture delivered before the Sheffield Society of Engineers and Metallurgists on Nov. 13, 1899.)—The author describes improvements in the construction of steam engines and boilers to suit the conditions of electric lighting and transmission of power by electricity. He discusses superheating by means of a reducing value, the air supply to boiler furnaces, and the working loads on generating stations. J. T. R.

712. *Condensers.* **S. Payne.** (Indus. and Iron. 27. pp. 331–332, Nov. 17, 1899.)—Paper read before the Manchester Society of Junior Electrical Engineers, Oct. 31, 1899.

713. *Complete Heat Cycle for the Steam Boiler and Engine.* **L. C. Auldjo.** (Indus. and Iron. 27. p. 427, Dec. 29, 1899.) Paper read before the Engineering Association of New South Wales.

714. *George Richard Autocar.* (Automotor Journal, 4. pp. 113–114, Dec., 1899.)—A general description of mechanism employed. The speed at which the governor controls the motor is adjustable by the driver. A. G. N.

715. *Motor Starting Device.* (Automotor Journal, 4. p. 122, Dec., 1899.)—A description of mechanism devised by E. Estcourt for enabling the driver to start an internal combustion engine from his seat on a motor-car. A. G. N.

716. *Entropy-Temperature Diagram of a Gas Engine.* **H. T. Eddy.** (Mech. Eng. 5. pp. 50–53, Jan. 13, 1900. Paper read before the American Society of Mechanical Engineers, Dec., 1899.)—This paper describes a graphical method of constructing the entropy-temperature diagram of a gas or oil engine when its indicator card is given. A. S.

717. *Steam-Driven, Water-Power Electric Plant.* (Amer. Electn. 11. p. 581, Dec., 1899.)—Description of plant at City of Columbus pumping station. J. T. R.

718. *Coke as a Steam Fuel.* (Indus. and Iron, 27. p. 283, 1899.)—Suggestions as to management of coke fires. J. T. R.

719. *Oil and Grease Extractors.* (Amer. Electn. 11. pp. 573–575, Dec., 1899.)—An illustrated description of several well-known types.

720. *Measurements in Testing Steam Plant.* (Mech. Eng. 5. pp. 113–116, Jan. 27, and 149–151, Feb. 3, 1900.)

721. *Trials of Two Pumping Engines.* (Engineer, 89. pp. 150–153, Feb. 9, 1900.) —Report by W. C. Unwin to Leeds Corporation.

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722. *Sherrin Accumulator.* (Elect. Engin. 24. pp. 724–725, Dec. 8, 1899.) —Illustrations are given showing the arrangement of this cell and the construction of its electrodes, but no definite particulars are supplied of its electrical capabilities. E. J. W.

723. *Majert Accumulator.* **A. Wilke.** (Elektrotechn. Ztschr. 20. pp. 783–786, Nov. 9, 1899.)—The chief feature of this accumulator, which is constructed by the Akkumulatorenwerk Oberspree Company, lies in the construction of the positive plate, to a description of which the greater part of the paper is devoted. The negative plate is of the Faure type, and is made in two forms, intended for stationary and travelling batteries respectively. The positive is a deeply chamfered or grooved plate of rolled lead, and is "formed" without a previous coating of oxide being given. Diagrams of this plate, and of the machinery specially devised for its construction, are given in the paper, as also is a table of the weight, capacity for different times of discharge, &c., of the various forms of the cell. N. L.

724. *Hartmann and Braun Electricity-Meter.* **Görner.** (Elektrotechn. Ztschr. 20. pp. 878–879, Dec. 14, 1899. Report read before the Elektrotechnische Verein Mannheim-Ludwigshafen, Oct. 25, 1899.)—This meter is due to Bruger, and is one of the kind in which a rotary magnetic field is produced by the mutual action of two alternating fields arranged at an angle of 90° to each other, and having a similar difference of phase. The field-magnet is **E**-shaped, of laminated iron, with two diametrically opposite pole-pieces excited by shunt coils, and an inner one, at 90° thereto, excited by a series coil. In the space between these three pole-pieces turns an aluminium drum over a stationary iron core which almost short-circuits the magnetic field. The drum-arbor bears a damping-disc rotating between the poles of permanent magnets. The difference of phase is produced by a transformer and a regulating resistance. The original paper is accompanied by a photograph of the instrument, and contains a very full discussion of the theory of its action. C. K. F.

725. *Tests of the Batault Energy Meter for Alternating Current Circuits.* **C. E. Guye.** (Écl. Électr. 21. pp. 290–295, Nov. 25, 1899.)—A first series of tests of this meter was taken with a view to verifying the law of proportionality for various loads. The percentage errors from mean value were as follows: For 1 lamp, + 0·56; for 2 lamps, — 0·25; for 5 lamps, + 0·22; for 10 lamps, — 0·09; for 15 lamps, — 0·25 (120 volts, 50 periods). Tests are also given for inductive loads. The meter is simple and not subject to derangement. W. G. R.

726. *Maximum Demand Indicators.* **L. J. Steele.** (Elect. Rev. 46. pp. 4–6, Jan. 5, 1900.)—This is a full description of the Halsey maximum-demand indicator, the principle of which is as follows: The rotating part of the supply meter drives the brake portion through the medium of a flexible spring coupling in the spindle, which is severed at that point; a pawl and ratchet serves to prevent relaxation of the spring coupling, and

a viscous material is employed at the junction of the two shafts to act as a retarding agent and to permit of sluggish action. The angular displacement of the armature, relatively to the brake disc, is shown by a pointer fixed to the upper half of the spindle. The device is virtually a recording transmission dynamometer. It is compared in detail with the Wright maximum demand indicator, and also with an arrangement, very similar to itself, described by Wilson in a paper read before the Northern Society of Electrical Engineers, March 8, 1897. E. D. P.

727. *Insulation of Bare Conductor Resting on a Glacier.* **J. Janssen.** (Comptes Rendus, 129. pp. 993–996, Dec. 11, 1899.)—This note is a record of some experiments carried out by Lespieau and Cauro on the behaviour of a bare wire of galvanised iron which is allowed to rest on the surface of a glacier. The wires used were each about 1,700 metres long, 3 mm. in diameter, and were kept 5 metres apart. The result of the experiments is to show that the wires may, for all practical purposes, be considered as perfectly insulated. A. H.

728. *Substitute for Indiarubber.* **W. F. Reid.** (Soc. Chem. Ind., Journ. 18. pp. 972–976. Discussion, pp. 976–977, Nov., 1899.)—A short account is given of the world's production of indiarubber and guttapercha. The composition and properties of an artificial substitute ("velvril") are described. This consists of nitrated castor or linseed oil mixed into a homogeneous mass with nitrocellulose. It burns slowly, and is not explosive. The hardness can be varied with the composition. This material is more stable than either indiarubber or guttapercha. Details of its specific insulation or dielectric strength are not given. It can be applied to wire either as tape or through a covering press. Its use for machine belting, hosing, cementing, varnishing, and for various special processes was described. A discussion followed. L. B.

729. *Cable Core Design.* **F. Breisig.** (Elektrotechn. Ztschr. 20. pp. 842–845, Nov. 30, 1899. Communication from the Kaiserl. Telegraphen-Versuchsamt.)—Various types of core are compared with regard to the "speed" at which legible signals can be transmitted through them. It is assumed that resistance and capacity cannot be reduced without increase of cost, and that a possible way to improve transmission is to introduce self-induction into the core, either by one of the various devices suggested by S. P. Thompson, or by combining iron wires or iron tape with the copper conductor. The lengths experimented upon were comparatively short—not exceeding 500 metres. The conductors in each case were insulated with three coats of guttapercha, sometimes sheathed with steel wires. Alternating currents of known periodicity and of simple sine form were used to represent the working conditions of telegraphy; it is, however, pointed out that the sine form does not accurately correspond to the impulses transmitted through cables. Calculations of the self-induction are based upon the measurement of the alternating volts between the ends of the core and the corresponding alternating current in the conductor. Volts are measured by a compensation method (*Ibid.* p. 448, 1891); current is measured similarly, using either a telephone or an electrodynamometer. The telephone is for this purpose extremely sensitive for 230 ∿ and upwards. For lower frequencies the electrodynamometer gives the best results; it is of service even down to 50 ∿. But since the zero-reading of the electrodynamometer does not, under the circumstances of a

"compensation" method, correspond to a unique relationship between the currents in its respective coils, its indications must be interpreted with caution. Zero may either mean no current or 90° phase difference. As a criterion, a self-induction bobbin connected in series with the fixed coil and provided with a short-circuiting key is employed. The first results relate to the measurement of the capacities of the cables at different frequencies. As the frequency increases from about 270 ∿ to about 530 ∿, the capacity appears to vary something like 2·5 per cent., sometimes an increase, and sometimes a decrease, according to the type of conductor. Similar results are obtained for the impedances and the apparent resistances of the cores at different frequencies; at frequencies from 234 ∿ to 427 ∿ the apparent resistances are approximately three times the ohmic resistances. The measurements relate (1) to a core whose conductor consists of a round copper wire 2·8 mm. diameter covered spirally with four iron strips in one layer to 4·46 mm. diameter, insulated to 11·59 mm., the whole being sheathed with steel wires: the self-induction, as measured, =0·00370 per km.; and (2) to a core whose conductor consists of a central round copper wire 3·10 mm. diameter, stranded with nine copper wires and three iron wires, each 0·8 mm. diameter, insulated to 11·76 mm., and sheathed with steel wires: the self-induction, as measured, =0·00262 per km. In another case (3) a central copper wire 2·8 mm. diameter is stranded with ten copper wires each 1·0 mm. diameter, insulated to 11·66 mm. and sheathed with steel wires: the self-induction, as measured, =0·0235 per km. The self-induction of (1) is thus 1·57 times that of (3). The capacities of (1), (2), and (3) are respectively 0·221, 0·236, and 0·212 mfds. per km. The resistances are respectively 1·124, 1·112, and 1·125 ohms. These figures show that, in order to keep the resistance approximately the same, the diameter of the conductor has been increased in the case of the strands containing iron, with consequent increase of capacity. Taking these factors into consideration, the maximum increase of "speed" due to the iron in the strand, assuming a true sine-form current, is estimated at 8 per cent. The author therefore concludes that it is impracticable by any self-inductive device effectively to improve the speed of signalling. R. A.

730. *Supplements to Railway Signalling.* (Elect. Rev. 45. pp. 1061-1063, Dec. 29, 1899.)—This is an illustrated description of Brierley's Signalling Apparatus, which can be used during fogs when the ordinary signals cannot be seen. The system is one which depends on the movement of normally balanced levers, fixed on the engine, by impact with obstructions placed on the side of the line; this gives rise to appropriate indications, on the engine itself, of the positions of the ordinary signals. The movement of the levers is made to close electrical circuits on the engine, and the indications are given by the ringing of an electric bell and the appearance of discs, which convey the information desired. W. G. R.

731. *Synchronising Phase Indicators.* **W. Ritter.** (Elektrotechn. Ztschr. 21. pp. 7–10, Jan. 4, 1900.)—The author gives a detailed account of various arrangements for paralleling three-phase generators, whereby it becomes possible to find out whether the speed of an incoming machine is too low or too high, and to ascertain the phase relation when the speed of synchronism has been reached. The principles underlying these methods have already been noticed in Abstracts Nos. 892 and 1774 (1899). A. H.

732. *Motor-driven Machine Shops.* **R. T. E. Lozier.** (Cassier, 17. pp. 158–165, Dec., 1899.)—Great economy is obtained by the facility with which

the men can adjust the tool speeds without changing pulleys, the result being that the best speed is adopted and not any speed that is good enough. Absence of belts is sanitary. Power is saved by avoiding slip and countershafts. Time is saved by arranging the machines regardless of alignment in the order taken by the work. M. O'G.

733. *Electric Drawbridge.* **W. S. Key.** (Elect. World and Engineer, 34. pp. 969–970, Dec. 23, 1899.)—The bridge and approaches over the Charles River, Boston, are 1,920 feet long, of which 1,090 feet is over water. The width of the bridge is 100 feet, and consists of two roadways, one above the other, allowing four car tracks in pairs. The draw span is 260 feet, and rests on a central pier, giving free passage for vessels 50 feet wide. The air and hydraulic pumps are worked electrically. The draw is opened by two 28 H.P. motors, and is operated about twelve times every twenty-four hours. M. O'G.

734. *Electrical Operation of Watertight Bulkhead Doors.* **R. M. Watt.** (Elect. World and Engineer, 34. pp. 895–896, Dec. 9, 1899. Paper read before the Society of Naval Architects and Marine Engineers.)—The system devised by F. T. Bowles is described. Each door is provided with a separate motor and power circuit, and can be independently operated by hand. The door is of steel plate riveted to a frame which slides in guides; the surfaces nearest the bulkhead are scraped to fit, and are forced together by wedges in the last half-inch travel. A bronze rack is bolted to the door, gearing through a pinion with another pinion keyed to the shaft of two worm wheels; a worm driven by a motor on the other side of the bulkhead gears with one of the wheels. The motor is of 1 H.P., compound wound. A switch fixed by the door is so arranged that the door may be opened or closed from either side of the bulkhead, or closed from a distant station; a limit switch cuts off the current when the door reaches either of its extreme positions. Sprague solenoid gravity controllers are also provided to throw in either the series or the series shunt windings of the motor. To open or close the door by hand through 6 or 12 inches of coal requires from 75 to 85 seconds; these operations are done electrically in 8 to 9 seconds, and require from 3 to 24½ amperes at 115 volts. Signal lamps are used to indicate at the distant station when the door is completely closed or opened. A. H. A.

735. *Electrical Machinery in the United States Navy.* **J. J. Woodward.** (Elect. World and Engineer, 34. pp. 813–818, Nov. 25; 853–855, Dec. 2; 891–895, Dec. 9, 1899. Paper read before the Society of Naval Architects and Marine Engineers).—This paper describes in detail, with numerous illustrations, the electrical plant installed on the battleships *Kearsarge* and *Kentucky*. All the auxiliary machinery on these vessels, except that connected with the main engines, is thus driven; the types of electrical machinery used are developments of those employed, to a less extent, on other vessels. Electrical driving is being applied on warships building for a foreign navy to a still greater extent. The duties performed electrically are tabulated, and the generating machinery, which consists of seven 50 kw. dynamos coupled to vertical compound high-speed engines, is described in detail. Shaft governors and forced lubrication are employed. The main switchboard is arranged for a three-wire system with 160 volts between the outers, with separate 'bus bars for lighting, power, and working the turrets. An equaliser board is provided for running the dynamos compound-wound in parallel. The arrangement of

distributing boards, both for power and lighting, and of the circuits, which are divided into "battle" and "normal," are described; a mixture of insulator, conduit, and wood-casing work is used for installing the conductors, according to their situation.

Three types of motor controller are used. The R controller is for reversing and controlling the speed by the rheostatic method. The B controller for hoisting is arranged like the R type on one side, but instead of reversing on the other side it connects the rheostat across the mains and shunts the armature to a larger or smaller portion of it; the effect of this is that small loads may be lifted at suitable speeds, or the arrangement may be used as an electrical brake for lowering. The P controller is used for rotating the turrets on the Ward Leonard variable voltage system. Each turret is operated by a separate generator, the field of which is varied by the controller; the motor fields are excited at constant pressure, so that the speed of rotation varies as the strength of the generator field, with constant torque. The direction of rotation is likewise varied according to the polarity of the generator field by the controller, which also provides electrical braking. Two 50 H.P. motors are fixed in each main turret, coupled by a shaft, and driving through bevel and worm gear. Controlling panels are used for fan motors and chain ammunition hoists, containing shunt rheostats for speed regulation, and automatic safety starting switches. Electrical brakes are used on the hoists. Each boat crane is fitted with a 50 H.P. motor, and can lift 18,000 lbs. at 25 feet per minute, with two motions, hoisting and turning. A special description in detail is given of the motors, which are generally shunt wound, and run at 400 r.p.m. All but the fan motors are of the enclosed four-pole type. Other auxiliaries are described, of various types. Two of the six deck winches are provided with two-speed gears, giving a lift of 2,200 lbs. at 300 feet per minute, or 18,000 lbs. at 50 feet per minute. Other electrical fittings are signalling apparatus, truck lights, diving lanterns, &c. A. H. A.

REFERENCES.

736. *Testing Electric Supply Meters.* **C. A. L. Prusmann.** (Elect. Engin. 23. pp. 38–40, 102–105, 166–167, 230–231, 340–341, 462, 590–591, 730–731, 1899.)—In this series of articles there is first described the most advantageous arrangement of the meter-room and store-room, the position and details of the benches, shelves, cupboards, lights, &c., illustrated by a plan. The labelling of the meter by the supply company or corporation is then described, this being followed by the details of a convenient system of book-keeping, comprising a series of forms for the various books, &c., employed. The arrangement of connections, terminals, and circuits is then considered at considerable length, this being followed by a detailed illustrated description of the resistances and instruments used. The whole question is dealt with in a very detailed manner, looking at it from the practical side. C. K. F.

737. *Switchboard Connections and Synchronising Arrangements for Polyphase Generators.* (Amer. Electn. 11. pp. 509–512, Nov., 1899.)

738. *Concentric House-Wiring.* **J. D. F. Andrews.** (Elect. Rev. 45. pp. 576–577, and pp. 613–615, 1899.)

739. *Electrical Specifications.* **E. K. Scott.** (Elect. Rev. 45. pp. 543–544, 1899.)

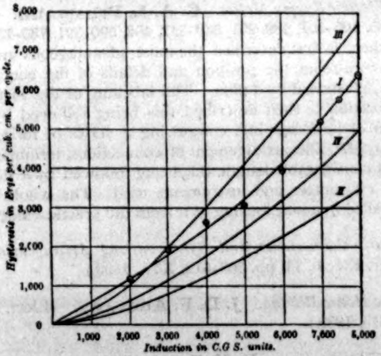
740. *Electric Welding as Used on the Russian Railways.* (Zeitschr. Elektrochem. 6. pp. 286–292, Nov. 16, 1899.)—Report read before the Association des Ingénieurs Électriciens, Liège.

GENERATORS, MOTORS, AND TRANSFORMERS.

741. *Compensated Revolving Field Generators.* **H. G. Reist.** (West. Electn. 25. pp. 309–310, Nov. 25, 1899. Paper read before the Ohio Electric Light Association, Oct. 11, 1899.)—This is a method of automatically adjusting the potentials of alternators for all variations and degrees of inductive or non-inductive load.

The shaft of the alternator which carries the revolving field also carries the armature of the exciter, which has as many poles as the alternator, so that the two operate synchronously. Besides the exciter commutator and the pair of collector rings which deliver the current to the field of the alternator, the shaft also carries three other collector rings, which are connected to taps in the exciter winding, in the same way as the rings are connected to the windings of rotary converters. Through these rings the exciter receives current from one or several series of transformers inserted into the lines leading from the alternator. This alternating current, passing through the exciter armature, reacts upon the exciter field, and in consequence the voltage of the exciter is due to the combined effect of the shunt field and the magnetic reaction of the alternating current. This current passes through the exciter in such a manner as to give the necessary rise of exciter voltage as the non-inductive load increases, and without other adjustment to give a greater rise of exciter voltage with additions of inductive load. W. G. R.

742. *Hysteresis in Armature Cores.* **F. G. Baily.** (Electrician, 44. pp. 323–324, Dec. 29, 1899.)—In this article the results are described of some experiments on testing the hysteresis of armature cores. A 5 kw. two-pole dynamo was used, the armature of which was 10 inches long, 6$\frac{3}{8}$ inches diameter ; the discs were $\frac{1}{16}$ inch thick and fitted the spindle closely. Special precautions were taken to eliminate frictional errors. Corrections having been made for eddy currents, the values plotted in Curve I. of the following diagram were obtained :—



The same iron could not be tested by the ballistic method, but Curve II. gives the values obtained by A. J. Ewing for soft charcoal iron in an alternating field, showing much lower hysteresis than with the rotating field. Curves III. and IV. are the results of tests made on samples cut from the same sheet, in a rotating and an alternating field respectively, showing similar results. The author found that the change in hysteresis-loss, due to mechanical vibration of the core, was negligible. In a non-uniform field, as in the case of slotted cores, the hysteresis value approaches that due to an alternating field. The conditions in a shallow ring armature probably produce an intermediate value of the hysteresis loss. A. H. A.

743. *Armature Windings.* **F. Emde** and **S. Olsen.** (Écl. Électr. 21. pp. 321–327, Dec. 2, and 369–375, Dec. 9, 1899.)—An elaborate examination of the conditions which must be fulfilled in order that a multiple armature winding may be possible. A. H.

744. *Compound Field Winding.* (Elekt. Runds. 17. pp. 56–57, Dec. 15, 1899.)—A description of a new form of compound field winding for dynamos or motors used by the Helios Company. The field magnet consists of a continuous iron ring with ring- or drum-wound exciting coils in slots or holes, resembling the stator of an induction motor, the compound turns being wound in the spaces between the shunt coils. A complete neutralisation of armature reaction is thus obtained and sparkless running at all loads with fixed brushes, the air-gap being reduced, thus increasing the efficiency. Such compound dynamos can be used for cell-charging without fear of reversal. L. B.

745. *Commutator Design.* **A. D. Adams.** (Amer. Electn. 11. pp. 568–570. Dec., 1899.)—Emphasising the importance of good commutator design, the author ascribes the majority of failures to mechanical rather than electrical defects, and discusses the details of construction. Usually with carbon brushes the width of brush may equal that of two segments, with a current density of 30 amperes per square inch of contact surface. Recent practice favours large diameters and short, wide segments rather than long and narrow bars. It is important that the taper of the segments, which depends only on their number, should be accurate. Mica insulation varies from 0·02 to 0·06 inch in thickness, and should not be so hard as to wear less quickly than the metal. The conical clamps which bind the segments together are preferably fixed to the sleeve with screws, instead of a nut. Details of the design of a small commutator are given, with illustrations. A. H. A.

746. *Advantages of Induction Generators.* **M. Leblanc.** (Écl. Électr. 21. pp. 328–332, Dec. 2, 1899.)—The first part of this paper is devoted to a discussion of the difficulties which are at times experienced in running alternators in parallel, the phenomenon of hunting being more particularly dealt with. In the second part the author proposes to get over the trouble of having to run synchronously by the use of induction generators, one of which would be provided with the special form of exciter designed by the author (see 1899, Abstract No. 908), and would thus determine the frequency and the P.D. of the supply, while the remaining generators would not in any way differ from ordinary non-synchronous motors. The paralleling of such machines would present no greater difficulty than that of continuous current dynamos. In the third part of his paper the author suggests a method of power transmission at constant (alternating) current, by means of induction generators coupled *in series.* It thus appears, according to the author, that by the introduction of induction generators we should get rid of all the peculiar difficulties attending the use of alternating currents, while at the same time retaining all the advantages of continuous-current working. A. H.

747. *Advantages of Two-Phase Generators.* **H. Girgensohn.** (Zeitschr. Elektrotechn., Wien, 17. pp. 624–627, Dec. 10, 1899.)—In this paper the author endeavours to justify the more general use of two-phase machines instead of single-phasers in cases where nowadays the latter only are employed. For a given type and size of machine, a two-phase winding corresponds to an output which is about 30 per cent. greater than that of a single-phase winding. If the two circuits of a two-phaser are linked together, and the machine used as a single-phaser, its output is practically the same as that of a single-phaser of the same size and type. Such a machine would probably run well in parallel with ordinary single-phasers. But in addition to this, it might be used for supplying power to two-phase motors, in which case its output would be increased by some 30 per cent. For supplying two-phase motors, a third wire, connected to the junction of the two windings, would be required. Thus it might appear at first sight as if a heavier outlay of copper in the mains were necessitated by the use of two-phase motors. The author points out, however, that the average power of motors connected to town mains amounts to 1¼ H.P., and that for motors of this size the single-phase type has a power-factor of 0·7 and an efficiency of 67·2 per cent., while for the two-phase one the corresponding figures are 0·73 and 73·6 per cent. When these facts are taken into consideration, as well as the much larger starting current taken by single-phase motors, it appears that the balance in favour of the latter type as regards total cross-section of copper in mains approaches the vanishing-point. A. H.

748. *Drop of Potential in Alternators.* **B. A. Behrend.** (Elektrotechn. Ztschr. 20. pp. 837–840, Nov. 30, 1899.)—Two methods are in use for determining the P.D. across the alternator terminals when supplying a current I to a *highly inductive* circuit, the open-circuit characteristic (exciting current—E.M.F.) and the short-circuit one (exciting-current—short-circuit current) being supposed known. If i is the exciting current, E and I_0 the E.M.F. and short-circuit current respectively corresponding to it, then according to method (1) the P.D. across the terminals is given by $V=E\left(1-\frac{I}{I_0}\right)$. According to method (2), on the other hand, if i_0 stand for the exciting current required to produce the short-circuit current I, the *effective* exciting current is supposed to be $i-i_0$, and if the E.M.F. corresponding to $i-i_0$ is E_0, then E_0 is the terminal P.D. By comparing the calculated values of the P.D. with those actually obtained for a number of alternators the author arrives at the conclusion that, although in some cases both methods give results which differ widely from those obtained experimentally, yet whereas method (1) is of considerable value to the designer in most cases, method (2) may be considered worthless. A. H.

749. *Alternating-Current Machinery.* **M. Leblanc.** (Écl. Électr. 20. pp. 171–178, 205–211, 253–261, 292–296, 404–413, 447–456, and 498–506, 1899.) —A continuation of the elaborate series of papers some of which have already been noticed in these Abstracts. The author further considers the theory of induction generators, and the conditions for their satisfactory working. Next comes the question of the excitation of asynchronous motors by means of the special device suggested by the author. This is followed by a long description and a mathematical theory of the special forms of rectifying transformers designed by the author. A. H.

750. *Parallel Running of Alternators.* **G. Benischke.** (Elektrotechn.

Ztschr. 20. pp. 870–873, Dec. 14, 1899.)—In this paper the author reviews in detail the various conditions required for successful parallel running. He points out that there are two distinct kinds of equalising current possible: the one, which is mainly an idle current, is due to unequal excitation of the machines, and may be removed by proper adjustment of the excitation; while the other represents power, and is due to speed fluctuations. The latter kind of equalising current may sometimes be removed by proper adjustment of the governor. The author next considers the disturbing elements which may be introduced under various conditions of working. In the case of direct-coupled generators difficulties may arise if the torque exerted by the engine is not sufficiently uniform, and if the machines happen to be thrown into circuit when the relative positions of their cranks are different. If under these circumstances it is permissible to interpose a choking-coil between the machine and the 'bus bars, the equalising current may be readily reduced. Another case which presents difficulties is that of a direct-coupled alternator driven by an engine whose torque is not uniform, and supplying power to a rotary converter. The only remedy in this case is again the interposition of a choking-coil. Large equalising currents may occur even in the case of belt, rope, or turbine-driven alternators if their E.M.F. waves differ considerably in shape; the frequency of such currents being a multiple of the fundamental frequency. The author finally discusses the troublesome phenomenon of the hunting of alternators. He refers to Kapp's paper on this subject (see 1899, Abstract No. 1085), pointing out that the resonance theory propounded by Kapp does not accord with observed results. He explains the phenomenon as an *interference* effect produced by the superposition of two or three consecutive waves of different frequency; the resulting "beats" fully account for the observed alternate increase and decrease in the equalising current. He further states that if Kapp's resonance theory were correct, then the introduction of even a small inductance would suffice to upset the conditions required for resonance; in practice it is found, however, that a small inductance produces no appreciable effect. The time of a complete oscillation of the armature (the oscillation being superposed on a uniform motion of rotation) is given by

$$t=2\pi\sqrt{\frac{M}{T}}$$

where M is the moment of inertia and T the greatest torque which could act on the armature (*i.e.*, the torque corresponding to a phase-displacement of ¼ period from the position of synchronism). The author states that as neither M nor T can be predetermined with any degree of accuracy, he does not believe that it is possible to predict whether hunting will take place or not. An ingenious mechanical model is described to illustrate the phenomenon of hunting. A. H.

751. *Enclosed Electric Motors.* **S. F. Walker.** (Elect. Rev. 45. pp. 956–957, Dec. 15, 1899.)—The author cites experiments proving that sparking at the brushes of a motor cannot ignite explosive gaseous mixtures, but states that colliery owners insist on the commutators being boxed in; he then discusses the advantages and drawbacks of the enclosed type of motor.

A. H. A.

752. *Rotary Converters.* **E. Wilson.** (Instit. Elect. Engin., Journ. 28. pp. 367–388, 1899.)—The machine experimented upon was a Siemens two-

pole dynamo furnished with four contact-rings connected to the commutator at four points 90° apart. It was used for transforming two-phase currents into a continuous current. The two-phase currents were supplied by a couple of similar alternators mechanically coupled so as to have their E.M.Fs. in quadrature with each other. Curves are given in the paper for the P.D. and current waves under varying conditions of load and excitation. The mechanical phase displacement of the converter armature was also studied, by connecting in series two instantaneous contact-makers, one of which was mounted on the alternator shaft, and the other on that of the converter, and introducing the two contacts into a circuit consisting of a battery and reflecting galvanometer. The distribution of the magnetic flux in the air-gap was examined by means of a double brush, making contact with two neighbouring commutator segments; curves showing the field distribution under various conditions are given, the most interesting being that obtained when the field of the converter was not excited, so that the flux was entirely due to the currents circulating in the armature. It was found in this case that the air-gap under each pole-piece could be divided into two regions in which the magnetic flux was of opposite sign. When run on a single phase the converter was found to drop out of step more readily, and the sparking at the brushes on the continuous-current side was much greater. A. H.

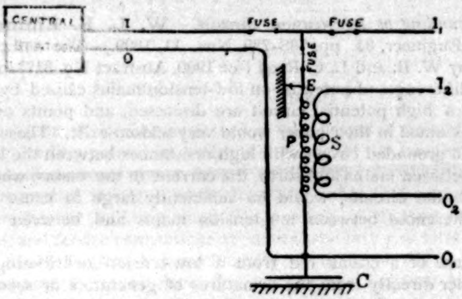
753. *Study of Rotary Converters.* **E. de Marchéna.** (Écl. Électr. 19. pp. 108–115, 1899; Industrie Électrique, Feb. 10 and 25, p. 58, 1899. See 1899, Abstract No. 506.)—In this paper the author studies the special case of a rotary converter the P.D. across whose terminals is required either to decrease or else to increase with increase of load. In the first case a shunt winding is sufficient for exciting the machine; in the second, a series winding with or without a shunt winding is required. Assuming that the limits between which the load may vary and the corresponding limits of P.D. are given, and that the connection between the resultant ampere-turns acting on the field and the E.M.F. is known (a straight-line relation being assumed within the given limits of P.D.), the author develops an elaborate analytical and graphical treatment of the problem, by means of which the variation of the P.D., the power-factor, and the angle of lag between the current and E.M.F. of the alternator supplying the converter, may be studied, as the load varies between the given limits. A. H.

REFERENCE.

754. *Starting and Regulation of Motors.* **C. F. Guilbert.** (Écl. Électr. 21. pp. 401–412, Dec. 16, 1899.)—Patents in connection with alternate current motors, rectifiers, &c.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

755. *Cable Breakdowns.* **G. Kapp.** (Elektrotechn. Ztschr. 20. pp. 896–900, Dec. 28, 1899.)—Soon after the establishment of the first alternating-current central stations with networks of concentric cables it was found that the switching on or off of sections of the cables was attended with the danger of a breakdown in the insulation between the outer main and the lead covering. It was also found that this danger could be avoided by following Neufeld's rule of always switching on the outer conductor first, and switching it off last. Breakdowns of the kind considered are due to resonance phenomena, and the author fully investigates the conditions under which they become possible. He first considers the case of a concentric cable running out from the central station and supplying a transformer which feeds an isolated portion of the secondary network. Let C_1 stand for the capacity of the outer conductor with respect to the lead covering (*i.e.*, with respect to earth), and C_2 for the capacity, also with respect to earth, of the outers of the entire remaining portion of the network supplied from the same station. If we suppose that the station end of the outer conductor of our cable is disconnected while the inner still remains in contact with its 'bus bar, a current will flow as follows: From the 'bus bar through the inner conductor and the primary coil of the transformer to the outer conductor of the cable, thence (as a displacement current) through the condenser of capacity C_1, next through the condenser of capacity C_2, and finally along the outer member of the remaining portion of the network to the station. Since C_1 and C_2 are joined in series, their joint capacity is $C_1C_2/(C_1+C_2)$, and if C_2 is very large in comparison with C_1, this becomes practically equal to C_1. It is obvious that since we have an inductive circuit (the primary of the transformer) connected in series with the condenser, powerful resonance may under certain conditions set in, and the dielectric of the cable be pierced. By considering some special cases such as frequently occur in practice the author finds that resonance is not at all unlikely to take place, and that the danger of breakdown is a very serious one. A similar investigation with respect to stranded cables shows that in their case the danger is much less than with concentric cables, To avoid all risks of breakdown the author recommends: (1) A strict adhesion



to Neufeld's rule; (2) Earthing of the outer conductor at a single point; (3) Omission of all safety fuses on the outer. Another class of breakdowns is then considered by the author. This has only been known to occur in networks of concentric cables whose inner and outer members respectively are all connected together both on the primary and on the secondary sides. The breakdown is brought about not by the disconnection of the outer conductor, as in the first case, but by the development of an earth on the inner conductor. It is said that a breakdown of this second kind is much more serious than one of the first kind, the insulation being generally pierced in a number of places simultaneously. The accompanying diagram explains how the breakdown is brought about. P and S stand for the primary and secondary of the transformer, I and O for the inner and outer conductors respectively. Let an earth occur at E. All the fuses shown will blow, but the transformer, being still across the secondary network, will receive a current, so that P will be the seat of an E.M.F. which will give rise to a current flowing to earth, thence through the capacity C (that of the outer member O_1 of the network), and back to P. Resonance in this circuit may occur under certain conditions, with a consequent breakdown of the insulation between O_1 and the lead sheathing. In this case the only reliable protection is to earth the outer at a *single* point (in order to avoid disturbance of neighbouring telephone circuits, and through a non-inductive resistance to prevent the occurrence of a dead short-circuit in case of accident), and leave out all safety fuses on the outer. A. H.

756. *Grounding of Low-tension Circuits.* **W. L. R. Emmet.** (Elect. World and Engineer, 34. pp. 738-739, Nov. 11, 1899.)—The author refers to the article by W. B. and L. C. Reed (see **1900**, Abstract No. 317) in which the dangerous differences of potential on low-tension mains caused by accidental crossing of a high potential circuit are discussed, and points out that the conditions assumed in their paper would very seldom exist. These conditions are that, on a grounded circuit with high resistances between the low-tension mains and between mains and earth, the current in the mains, when crossed by high-potential circuits, would be sufficiently large to cause dangerous potential differences between low-tension mains and between mains and earth.

In the case of a circuit fed from a low-tension distributing network, supplied either directly from the armatures of generators or secondaries of large transformers, the resistances of these apparatus being so low, an enormous current would be required to raise the differences of potential at their terminals to a dangerous degree—in fact, the conductors would probably be destroyed instantly at the points of crossing. Similarly with the grounding connections, which should be of low resistances. The character and number of ground connections for circuits should be governed by rules.

The failure of ground connections, as a safety device, is likely to occur in the event of low-pressure circuit fuses blowing, in which cases a high potential difference may be between the wires of the circuit. This, however, is easily prevented by the arrangement of fuses and ground connections. In the case of a circuit fed from a house transformer, the transformer fuses would afford a sufficient protection in the event of a cross between the two transformer coils.

The author finally points out W. B. and L. C. Reed's method of using an automatic cut-out in the main circuit, actuated by an excess of current through the ground connections or through a certain connection between the mains, has the disadvantage of being slow in action, the damage being done before the cut-out can come into play. This is the drawback of all earthing devices, which, the author states, cannot take the place of permanent ground connections. E. D. P.

757. *Best Number of Feeding-points in a Distributing Network.* **A. Sengel.** (Elektrotechn. Ztschr. **20.** pp. 807–809, Nov. 16, and 826–829, Nov. 23, 1899.)—The total cost of a network is made up of the cost of the feeding and distributing systems. By making the number of feeding-points very large the cross-section of the distributors may be greatly reduced, and thus the cost of the distributing system lowered—at the expense of the feeding system. On the other hand, by using a small number of feeding-points the cost of the feeders is reduced, while that of the distributors is increased. It is obvious that for a *given* distributing network there will be one particular number of feeding-points for which the total costs will be a minimum. The author investigates this problem for networks consisting of square, triangular, and hexagonal meshes, and finds that the expressions obtained for the best number of feeding-points are practically independent of the shape of the meshes, but that they depend on whether the network is unbranched (*i.e.*, the feeding-points connected by simple lengths of distributors) or branched (*i.e.*, with a number of distributing *meshes* connecting the feeding-points). The following formulæ are deduced by the author :—

$$\mathrm{F} = \left.\begin{matrix} 0{\cdot}5 \\ 1{\cdot}0 \end{matrix}\right\} \frac{\mathrm{A}}{e} \sqrt{\frac{100b}{\mathrm{L}\left(m + d + \frac{s}{2\mathrm{L}}\right) pk\sigma}}$$

$$l = \left.\begin{matrix} 1{\cdot}4 \\ 1{\cdot}0 \end{matrix}\right\} \sqrt{e}\,.\sqrt[4]{\frac{\mathrm{L}\left(m + d + \frac{s}{2\mathrm{L}}\right) pk}{100b\sigma}}$$

where F = number of feeding-points ; A = total output of network, in watts ; e = P.D. at feeding-points, in volts ; $d + ba$ = cost of (single) cable, per metre length, of sectional area a square millimetres ; L = length of (single) feeder ; m = cost of laying a metre length of cable (not including cost of digging trenches or building conduit) ; s = cost of making feeding-point connections, and feeder connections at central station ; p = total percentage drop along double feeder ; k = conductivity of copper (= 57) ; σ = output, in watts, per square metre of network ; l = distance between two feeding-points in metres.

The use of these formulæ is illustrated by a numerical example. The upper figures (0·5 and 1·4 respectively) in the formulæ are to be used for unbranched, and the lower (1·0 and 1·0) for branched networks. Where the load is distributed irregularly, it is best to subdivide the entire network into a number of districts (for each of which σ may be considered as contant) and apply the formulæ to each district separately. A. H.

758. *Electricity as a Motive Power.* **J. S. Raworth.** (Electrician, **44.** pp. 41–44, Nov. 3, and 73–76, Nov. 10, 1899. Paper read before the Manchester Association of Engineers, Oct. 28.)—The author compares steam-driven manufacturing works (*i.e.*, with the usual belt, rope, or other gearing transmissions) with electrically driven works, either with supply from outside sources or with electrical generators at the works. Examples are worked out showing the actual costs of the systems, and other general advantages of the two methods are pointed out.

A long appendix of several tabulated results of experiments is added, including losses in belts and shafting, and tests of machine-tools driven by electric motors. Also tables and curves of efficiency tests of various electric motors, both direct- and alternating-current. E. D. P.

759. *Electric Power in Powder Factories.* (Engineering, 69. pp. 115–118, Jan. 26, 1900.)—A short, illustrated description of the electric power equipment of three new United States Government smokeless powder factories. The power is supplied in each case by Westinghouse double-current multipolar generators, giving both direct current at 500 volts for lighting and traction, and two-phase currents at 400 volts and 60 ∿ (in one case 120 ∿) for power. For the latter purpose Westinghouse C-type induction motors are used, which, having no sliding contacts whatever, reduce the danger of explosion to a minimum. L. B.

760. *Impulse Wheel Generating Plant.* (Elect. World and Engineer, 34. pp. 754–755, Nov. 11, 1899.)—The turbine is designed to work off a pumping main when the supply of water is greater than the demand. The speed of 650 revolutions per minute required for the direct coupled generator necessitated the use of 18-inch diameter impulse wheels; and, in order to obtain 110 H.P. from the turbine, 18 nozzles were required. The turbine is arranged with 6 runners and 3 nozzles to each runner, in order to avoid the expense of 18 contracting nozzles. The regulation is effected by cutting off one jet at a time by ordinary butterfly valves. In this way the efficiency of only the one jet actually being cut off is affected.

The paper is illustrated, and contains a full account of an interesting machine which has been running for over a year at Columbus, Ohio.

M. G. W.

761. *Edinburgh Electricity Works.* (Elect. Engin. 24 pp. 553–556, Nov. 3, and 582–587, Nov. 10, 1899.)—Such rapid progress in electric lighting is taking place in Edinburgh that the Dewar Place works, which can supply 3,000 kw. as a maximum, have been found to be far too small for the extensions required, with the result that a larger site has been acquired, and an entirely new works has been designed by Kennedy. The old works generated energy on a 230-volts, direct-current, three-wire system, and also on a 2,500-volts alternate-current system. The new works will generate only direct current, to be distributed on the three-wire system with 460 volts across the outers. Plans and particulars are given of the new works. There are to be four boiler-houses, each containing nineteen boilers, arranged in pairs on each side of the two engine-rooms. Each of these engine-rooms contains thirteen steam-dynamo sets, each of 1,200 I.H.P., besides the smaller sets of boosters and balancers required. The flues and chimneys of the boiler-rooms are so arranged that sections of the flues can be shut off for cleaning purposes without interfering with many boilers. Two main flues run the full length of each boiler-house, and each of these can be made to discharge into either of the two chimneys, there being two chimneys for each pair of boiler-houses. Three dampers are placed in each of these main flues, one at each end and one in the centre, so that, by regulating these, the gases from a block of boilers may be led into either of the chimneys, or divided between the two.

The buildings now erected extend over rather more than a quarter of the area the works would occupy were the whole completed. The thirteen boilers erected are of the dry-back marine type, each capable, when fed with ordinary grades of Scotch coal, of evaporating 11,500 lbs. of water per hour. Particulars and dimensions of these boilers are given. Automatic stokers are fitted to each, being driven in groups of ten by steam engines. The stokers are fed from the coal-stores, above the boiler-house, through shoots in the floor. The quantity of coal delivered to each boiler is measured by means of an iron box, placed between the shoot from the coal-stores and the hoppers of the stokers. Shutters are placed at the top and bottom of the box; with the lower shutter closed the upper one will be open and the box fills with coal. The shutters are operated together from one lever by the fireman; one motion of the lever will close the upper and open the lower shutter, while the reverse motion will open the upper and close the lower shutter. The box is graduated to hold 5 cwt. of coal when full, a regulating plate being fixed inside, so that its capacity may be varied slightly for changes in weight, due to different sizes of coal. The coal is run from this box through a divided shoot to the hoppers of the two stokers on the boiler. The stokers may be fed direct by hand, and the fires also. A duplicate steam main runs the length of the boiler-house, with branches from each boiler to each main. The ring main of the engine-room is fed from these, separators with Geipel steam-traps attached being placed at the entrance to the engine-room and half-way round the steam-ring. Three Worthington compound duplex feed-pumps are installed, also two Berryman feed-water heaters. Condensing plant is to be installed eventually; the surface system will be adopted.

The main generators are Willan's engines directly coupled to Mather & Platt dynamos. Two of the machines yield 840 amperes at 230 volts, and six larger sets of about 1,200 H.P. are on order. The guarantee figures of the latter are that at full load the steam consumption shall not exceed 17 lbs. per E.H.P., or 15·8 lbs. per B.H.P. hour.

Two sets of accumulators are installed, each consisting of 140 cells of the Pritchetts and Gold type. Their capacity is 2,000 ampere-hours at a 400 ampere rate, or they can give 800 amperes for half an hour on emergency.

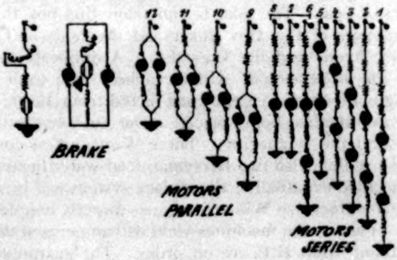
The switchboard arrangement is described in full. The usual method of proportioning all feeders so that the same drop shall be obtained with each when at full load has been abandoned. The dynamos, cables, &c., are designed so as to allow for a drop of 100 volts on the long-distance feeders and for a drop of 50 volts on the short feeders. The switchboard is arranged, therefore, so that two distinct circuits can be formed; each may have several machines paralleled on it, and yet one may help the other by motor-driven boosters to equalise the generator loads. E. D. P.

762. *Electric Lighting at Windsor.* (Elect. Engin. 24. pp. 717–719, Dec. 8, 1899.)—A full description of the street lighting is given; both arc and incandescent lamps are used. The incandescent lamps, over 300 in number, are coupled to the mains in a novel manner, the circuits being so arranged that all the lights can be switched on or off from one point in the centre of the town. For this purpose lengths of small subsidiary mains are used in conjunction with automatic relays. Diagrams of the arrangement are given.

The company's charge for the supply and maintenance of each 16-c.p. lamp is £3 12s. 6d. per annum in Eton, and £3 7s. 6d. per annum in Windsor; for each 2,000-c.p. arc lamp £22, and for each 500-c.p. arc lamp £16.

Some particulars are given of tests on a new 200-H.P. Peache engine coupled to a 120 kw. Holmes dynamo. With an output of 162·6 E.H.P. the efficiency was 83·13 per cent.; the steam consumption at this load, with the engine running non-condensing, was 20·78 lbs. per I.H.P. hour, or 25·8 lbs. per E.H.P. hour. At half-load the steam consumption per E.H.P. hour was about 32 lbs. With full load on and engine running at 423 r.p.m., a rise of 2 per cent. in speed was produced by throwing load off suddenly, the momentary rise being 5 per cent.; with the sudden change of load from full to half an increase of speed of 1·6 per cent. was produced. Specimens of indicator diagrams obtained during the test are given. E. D. P.

763. *Como Electric Tramway.* **R. v. Podoski.** (Elektrotechn. Ztschr. 21. pp. 3–7, Jan. 4, 1900.)—An illustrated description of a tramway equipped by the Helios Company. The line has a short gradient of 6·8 per cent.; full



particulars and tests are given of the brakes for holding the car in check when descending. The controller connections to the two motors are as shown in the accompanying figure. E. K. S.

764. *Isle of Man Tramways.* (Electrician, 44. pp. 458–462, Jan. 26, 1900.)—An illustrated description of a water-driven electric plant installed by the Isle of Man Tramways and Electric Power Company for the generation of power for the Douglas-Laxey and Ramsey electric lines. The power generated, about 140 H.P., is sufficient for the winter or light season load on these lines. The summer load is supplied by steam-driven plant, about 2,200 H.P. being required.

The Laxey River furnishes the power, a working fall of 38 feet being obtained. Some details of the construction of the weir, races, pipe-line, &c., are given. Two 12-inch turbines of the Victor type, one bipolar generator, and one booster are installed. The electrical machines are coupled by clutches to the turbines, which can be also rigidly coupled together. Main connections are made from the switchboard to the main switchboards at the steam-driven stations. The turbine station works in connection with three battery substations, whereby full load is kept on the main generator. E. D. P.

765. *Burgdorf-Thun Three-Phase Electric Railway.* **C. Rochat.** (Street Rly. Journ. 15. pp. 853–860, Dec., 1899.)—The line is 40 km. in length, and at Burgdorf connects with the standard steam road between Berne and Olten, whilst at Thun it runs in connection with the Berne-Thun Interlaken Railroad. In order to make close connection with each of these lines a larger train service was necessary than would have been convenient with steam power; and again, the grades, though not very steep, would yet have been considerable for steam-operated trains. With electricity, on the other hand, the grades are easily surmounted. Single cars can be run frequently, and by means of three-phase transmission at high voltage, advantage can be taken of a water power at Spies about 10 km. from Thun.

Power Station.—Four turbines, located on the Kander River, operate under a fall of 63 m. with an average volume of 10,000 litres of water per second, equal to 6,300 H.P. Each generator has a capacity of 900 H.P. and produces three-phase current at 4,000 volts, which is raised to 16,000 volts in step-up oil-transformers. The lighting is kept distinct from the power circuit.

Track.—The line is single track throughout, the maximum gradient 2¼ per cent., and the minimum curve-radius 250 m. The rails, 36 kg., are in 12 m. lengths, and the complete track weighs 110 kg. per metre. The rails are bonded by having the under side of head and top of base grooved and filled with zinc, as are also the angle plates bearing upon these parts. Cross-connections are made at 100 m. intervals by 8 mm. wires.

High-tension Line.—The pole line for the 15,000 volt transmission consists of three copper wires, each 5 mm. diameter, carried on porcelain double-petticoat insulators. Between Spies and Thun the wires are carried on latticed poles set in concrete, but along the track the poles are of wood, the maximum span being 35 m. There are Siemens-Halske horn lightning arresters at the entrance to the power station and at each substation, and to avoid short circuits to earth after atmospheric discharges, water rheostats are introduced in the earth connection.

Substations.—There are 14 transformer substations each containing a 450 kw. oil-transformer, having a ratio of 15,000 to 750 volts. The transformers and switchgear, &c., are enclosed in metal housings, surmounted by the overhead construction for the high-tension wires.

Trolley Wires.—These are two in number, 8 mm. diameter, carried 5·1 m. above the track, and 1·1 m. apart. Double insulation is employed between trolley wires and poles, the latter spaced 35 m. apart except at curves. The bow sliding trolley is used, and there are no overhead frogs except at turnouts. At those points where the wires cross, section insulators are installed, and as the cars carry four trolleys, two at each end, contact with at least one set is always secured.

Electric Locomotives.—These are two in number, of the following dimensions: Wheel base 3 m., length of body 6 m., length between buffers 7·2 m., diameter of wheels 1·3 m., and weight complete 28 tons. They are employed principally for freight traffic, and are capable of hauling 100 tons (freight) at a speed of 18 km. per hour on 2¼ per cent. grade, or 50 tons (passengers) at 36 km. per hour. Each locomotive is equipped with two motors of 150 H.P. running 300 r.p.m. at 750 volts. They are placed in the middle of the locomotive, and at either end of the same shaft, the stators being mounted on the locomotive framework.

The rotor shaft can be thrown into gear with either of two trains of gears (for the two speeds) connected with the axles. For facilitating the mounting and dismounting of the rotors, the sides of the locomotives have openings through which the shaft can be removed.

The starting rheostat is composed of helical coils of ribbon, separated into three sections corresponding to the three phases and connected to a commutator fitted with carbon brushes. At each end of the locomotive are two switches, one for making and breaking the circuit, and the other for reversing.

Each locomotive carries a transformer for reducing the pressure from

750 volts to 100 volts. Part of this low-tension current is used for operating a motor compressor of 3 H.P. for the air brake, and part for lighting.

Motor-Cars.—At present there are six motor-cars, each capable of carrying 68 passengers, the weight of the car fully equipped being 32 tons. The following are the leading dimensions: Length of body 12·2 m., width of body 3·05 m., distance between centres of trucks 9·5 m., wheel base 2·2 m., diameter of wheels 1·02 m., and length over all 16·3 m. Four 55 H.P. motors are carried on each car (one to each axle), and they run at 600 r.p.m. with load, and 586 without. The starting rheostat is similar to that on the locomotive, as is also the motor compressor, &c.

Trail Cars.—There are five trail cars of the two-axle type—two to carry each 55 passengers, two to carry each 40 passengers, and one combination passenger, postal, and baggage car carrying 20 passengers.

Running.—As the cars are operated by three-phase, a practically constant speed of 36 km. per hour is maintained. The cars can be braked quickly and stop in about three-quarters of a minute; a table of tests made on the 2½ per cent. grade is given. Tests of the power consumption at starting gave the following results:—

(*a*) One motor and one trail car on 2½ per cent. grade straight track, 260 amperes at 760 volts.

(*b*) Same as above, but on curve 250 m. radius, 330 amperes at 850 volts.

(*c*) The maximum consumption of the electric locomotive with a complete train of 50 tons at 36 km. per hour never exceeded 300 amperes at 700 volts.

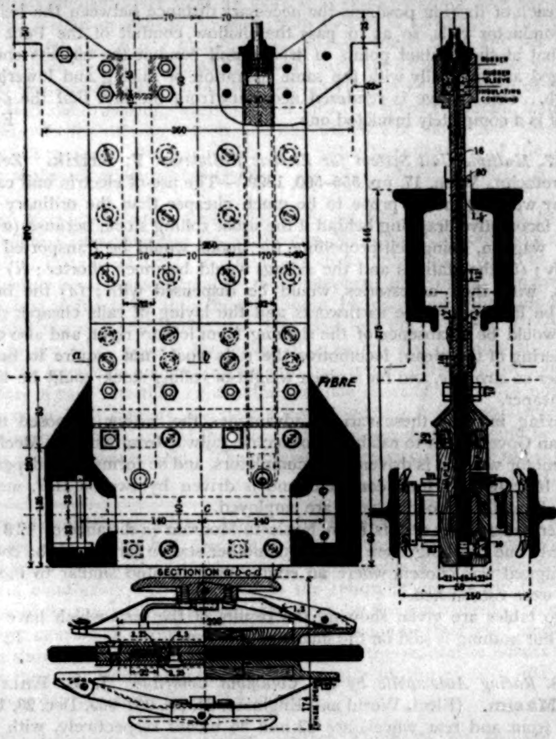
It has been found not advisable to run two trains of cars at the same time in a section fed by one transformer. With two trains they should be six minutes apart, and with three trains the headway is ten minutes. (The article is abundantly illustrated.) E. K. S.

766. *Electric Conduit Construction in Paris.* **A. N. Connett.** (Street Rly. Journ. 15. pp. 845–852, Dec., 1899.)—In some of the larger French cities the trolley is forbidden in certain streets, and conduit lines have been laid down. In Paris the Bastille-Charenton line has a short section of conduit with the central slot somewhat similar to the Metropolitan Railroad Company of Washington, except that the cast-iron insulator shields are bolted directly to the bottom flange of the slot rail. The insulator pits are also covered with cast-iron plates, placed low enough to allow of being paved over, this being necessary, as by the municipal regulations, manhole covers must be reduced to a very strict minimum.

In new lines which were projected, the most important being the "St. Ouen-Champ de Mars," the French Thomson-Houston Company made every effort to continue the construction of this central slot conduit, but were met with opposition from the authorities, and were therefore obliged to adopt the side-slot conduit. Compared with the centre this method has several disadvantages: (1) The question of slot closure becomes doubly important from the fact that the wheel flanges, as well as the plough shank, must pass into the slot. (2) The entire car traffic passing on the overhung yoke seats makes a stronger construction necessary. (3) The plough insulation is rendered more difficult from the splash of mud and water directly on it from the wheels. (4) It is fundamentally impossible to make a really satisfactory side-slot switch.

In Paris the last difficulty has been avoided by the device of deflecting the slot from the side to the centre at such points (Avenue Marceau), where switches are absolutely necessary.

On some lines the plough has been so constructed that it will pass through the normal slot, but this is after all of slight practical value. In Paris the author decided not to adopt this method, but to make the plough thoroughly mechanical and of high insulation resistance, arranging for its withdrawal at certain points. The withdrawal is effected through cast-steel doors in the slot, which can be raised and lowered by a removable lever carried on the car, or, where traffic is heavy, attended to by a man set apart for the purpose.



(Good illustrations are given of the conduit and of the trap-door arrangement. The drawing of the plough is here reproduced.)

The conduit walls are of concrete, made to shape by sheet-iron formers, which are afterwards withdrawn through the slot. Being in three separate parts this withdrawal is quite easy.

At one point the line crosses the Seine by the Pont Alma, and as the height of the masonry arches would not permit of the regular conduit, a specially shallow one had to be designed. It consists of a continuous cast-iron **U**-tube, nearly covered in by steel plates, upon which special **Z** bars are bolted to form the slot. This construction necessitates the raising of the conductor bars 4¼ inches above their normal level, and special means had therefore to be made to raise and lower the plough when going over the bridge.

The design of the plough support was difficult, because the conditions to be fulfilled were : (1) That the plough should be able to slide laterally the full width of the track. (2) That at its central position it could be raised clear from the conduit so as to be carried over the trolley section, and, *vice versâ,* to be lowered into the conduit. (3) That it could be raised and lowered from each of its side positions the necessary distance between the height of the conductor rails, so as to pass the shallow conduit of the Pont Alma. (4) That at the contact points of trolley and conduit the circuits could be changed automatically with the same operation of raising and lowering the plough. This change is rendered necessary from the fact that the conduit circuit is a completely insulated one. E. K. S.

767. *Multiple Unit System for Electric Railways.* **F. Křižik.** (Zeitschr. Elektrotechn., Wien. 17. pp. 555–560, 1899.)—The use of electric unit cars for railway working should prove to be much cheaper than the ordinary heavy steam locomotive dragging behind it the usual rolling stock, because (*a*) each motor waggon, being self-propelling, the goods would be transported more quickly ; (*b*) the stations and the sidings would be much shorter ; (*c*) water basins, with their accessories, would be dispensed with ; (*d*) the bridges could be lighter and the earthworks and the laying of rails cheaper ; (*e*) as there would be an absence of the shaking from left to right, and also of the hammering of the steam locomotive, the rails would not require to be held together so strongly, and for a given weight of rolling stock could be lighter and cheaper.

Having in view these various advantages the author proposed to the Austrian Government to establish an electric railway from Nusle to Mechenic. Each motor waggon is driven by accumulators, and so forms an independent unit. It weighs 12 tons complete, and is driven by two 35 H.P. motors ; 280 Tudor cells in wooden cases are employed.

After satisfactory results from Nusle to Modram (a distance of 12·3 km.), with only one charging there and back, another station farther in the country at Konigsaal was chosen, where an engine and dynamo similar to those at Nusle were established.

Two tables are given showing the results of the tests which have been made, but nothing is said on the financial question. E. K. S.

768. *Racing Automobile by the Columbia Company.* **J. B. Entz** and **H. P. Maxim.** (Elect. World and Engineer, 34. pp. 967–969, Dec. 23, 1899.) —The front and rear wheels are 32 and 36 inches respectively, with solid rubber tyres and ball bearings. The entire driving system is suspended in a self-contained case, or "torpedo," which is pivoted on the rear axle, and includes motor, pinions, balance gear, and all bearings. The forty-eight all-lead accumulators weigh 980 lbs., the carriage ready for them 1,200 lbs., the capacity is 124 ampere hours at 22 ampere discharge. One hundred miles were covered at an average of 12·9 miles per hour for 13·6 kw. hours expended. A further 50 miles was then run after recharge at an average of 20 miles per hour. M. O'G.

769. *Krieger Electric Car.* **J. Reyval.** (Écl. Électr. 21. pp. 481–486, Dec. 30, 1899.)—The author describes the general construction and design of the latest models, as well as of previous forms. The unusual feature of these

cars is that separate motors drive each of the front steering wheels; no differential gear is in consequence used. A device for steering by means of varying the two motor speeds is described, but has been abandoned. Speed regulation is effected, primarily, by changing from series connection of accumulators to the two halves of battery in parallel, and, secondarily, by varying the motor (field and armature) connections. Eight speeds are provided, giving from 4 km. per hour to 25; diagrams of connections are given. Fulmen accumulators are used, 44 cells, B 17 type, weighing 10·4 kgs. each. The total weight of vehicle (Victoria) with battery is 1,840 kgs. The car is said to run 80 km. on one charge, at an average speed of 18 km. per hour. The four-pole motors weigh 65 kgs. each; they are 3 kw. machines working at 2,500 revolutions per minute, and have an efficiency (maximum) of 87 per cent. Helicoidal gearing, with a ratio of 16·5 to 1 speed reduction, transmits the energy to the driving wheels, and the efficiency of motor and gearing is given as 82 per cent. No particulars as to either the efficiency or the depreciation of the accumulators are given. A. G. N.

770. *Method of Testing Rail Joints.* (Street Rly. Rev. 9. p. 812, Nov. 15, 1899.)—The Chase-Shawmut Co., of Boston, Mass., have introduced a device for testing joint resistance. It consists of three pole-spears, wired to a case containing a continuous interrupter and a telephone attachment. An assistant strikes two of the poles into the rails about 18 inches on either side of the joint, and the operator strikes the third pole into the rail about 4 feet from either of the other poles. By means of a switch the operator alternately throws the telephone and interrupter into the circuit containing the joint and the 4 feet of rail. He then adjusts the distance apart of the poles until the noises from both circuits are nearly equal, getting a fine adjustment by balancing one circuit against the other, when no sound at all should be heard if their resistances are equal. The ordinary return circuit in the rail is used. E. H. C.-H.

771. *Electrolysis of Water Mains.* **L. I. Blake.** (Elect. World and Engineer, 34. pp. 934–935, Dec. 16, 1899.)—Owing to the greater resistance of the joints compared to the pipe itself, water mains cannot be regarded as uniform conductors. If connected to the return of an electric tramway a portion of the current is shunted at the joint by the water inside and outside the pipe, causing electrolytic corrosion. Numerous tests of pipe lengths are given, showing that from 80 to 90 per cent. of the resistance occurs in the joints, the pipes being pitted inside and outside on the positive side of the joint to a depth in some cases of ¼ inch. L. B.

772. *Merriman's Contact System.* (Elect. Engin. 24. pp. 467–468, 1899.)—A mechanical contact system. The car wheels depress the short arm of a lever whose other end (heavily weighted to prevent lighter weights moving the lever) brings a contact-pin to the surface plate. E. H. C.-H.

773. *Track Construction Used in Scranton, Pa.* (Street Rly. Rev. 9. pp. 744–746, Nov. 15, 1899. Paper read before the Pennsylvania Street Rly. Association, Oct. 11–12, 1899.)—A light, 57-lb. T-rail has been used, strengthened at the joints by an inverted 4-feet length of the same rail, placed under the joint and secured by eighteen ¾-inch rivets driven by a portable pneumatic riveter. Four of the rivets are copper and form bonds. Other inverted lengths of old T-rail are used as ties, riveted to the foot of the rail every 10 feet; this in

addition to ordinary tie rods at 10-feet centres. The rails rest on 6 inches of concrete, and the paving is vitrified brick with a special shaped brick next the rail fitting into the web and having a groove for the wheel flanges.
E. H. C.-H.

774. *Recuperation of Accumulators on Vehicles.* **P. Bunet.** (Ind. Élect. 8. pp. 464–467, 1899.)—Sarcia, in 1895, published the results of experiments on the Paris accumulator tramways, which conclusively proved that on descents a considerable portion (from 23 to 42 per cent.) of the energy expended in ascending could be returned to the battery. The author shows that the reason why this result has not been utilised on tramways is that it involves the use of a shunt motor, which takes more current to give the same torque than a series motor, and which consequently loses in efficiency uphill more than it gains by recuperating the cells on a down gradient. A shunt motor under these conditions will require a higher discharge-rate from the battery: it will also spark. On the other hand, the sparking at the controller contacts will be less with a shunt motor, because the armature circuit is never completely broken on account of the fields. Starting torque may be increased by compound winding, but this complicates the connections for recuperation. For automobiles the conditions are different, because there are fewer stops and it is more frequently necessary to go slowly.
E. H. C.-H.

775. *Magnetic Observatories and Trolley Wires.* **S. Wächter.** (Elektrotechn. Ztschr. 20. pp. 655–657, 1899.)—A description of the double trolley line adopted in Strassburg to prevent magnetic disturbances due to traction currents. The forward and return conductors are placed 80 cms. apart, and are supported by a compound insulator whose constituent parts are connected by a rod of insulating material. The cars are provided with double trolley poles. The arrangement is said to work satisfactorily. A. H.

776. *Illuminating Power of the Alternating Arc.* **A. Blondel** and **Jigouso.** (Écl. Électr. 21. pp. 141–142, 1899. Paper read before the Assoc. française, Boulogne.)—The illuminating power of the alternating arc depends to an enormous extent upon the nature and diameter of the carbons, on the density of the current, and on the length of the arc. These details must be kept in view in comparing different arcs. Increasing the frequency of the alternations is not necessarily a benefit; the carbons must be selected with a view to the actual frequency employed. Large arcs have much higher efficiency than small ones, but within limits thinner carbons are better. The duty is much higher if the curve of the current (not of the E.M.F.) be made rectangular; but there is as yet no applicable method of doing this on a commercial scale. The total luminous flux is from 20 to 40 per cent. less with alternating currents than that corresponding to the same amount of energy with continuous currents; the amount of difference depends greatly on the kind of carbons and on the voltage under which they are used. A. D.

REFERENCES.

777. *Arc Lamps.* **G. Richard.** (Écl. Électr. 21. pp. 16–24, 1899. Read before the Association Française pour l'avancement des Sciences.)—Descriptions of arc lamps of Bergmann, Thomson, Houston, Lewis, Johnson and Wunderlich, Sandy, Brown, Vassier, Stralsund, Mersch, Oliver, Pomeroy, Arter, Ischieret, Willman, and Lamp de la Company de l'Industrie Électrique. (See 1899, Abstracts Nos. 958, 1449.)

778. "*Belden*" *Arc Lamp.* (Elect. World and Engineer, 34. pp. 869–870, Dec. 2, 1899.)—Description of the Belden Enclosed Lamp.

779. *Swiss Engineering.* **E. K. Scott.** (Lightning, 16. pp. 375 and 380, 1899.)

780. *Warsaw Central Station.* (Elect. World and Engineer, 34. pp. 690–692, Nov. 4 ; 735–737, Nov. 11 ; 775–778, Nov. 18 ; 856–858, Dec. 2 ; 896–898, Dec. 9, 1899.)—1. Report by W. H. Lindley. 2. Description of generating station. 3. Arrangement of circuits. 4. Transformers. 5. The Street Railway System.

781. *Hereford Electricity Works.* (Elect. Engin. 24, pp. 750–757, Dec. 15, and 782–783, Dec. 22, 1899.)

782. *New Tramcar.* (Electrician, 44. p. 255, Dec. 15, 1899.)—Illustrated description of a tramcar for the Dublin United Tramways Company.

783. *Electrical Quarry-Installation.* (Elect. Rev. 45. pp. 1007–1010, Dec. 22, 1899.)—Description of an electrical transmission of power plant near Dumfries. J. T. R.

784. *Aluminium Conductors.* (Ind. Elect. 8. pp. 512–513, Nov. 25, 1899.)—Describes briefly sizes and arrangement of the aluminium conductors at the Snoqualmie and Blue Lakes installations. (See also 1899, Abstract No. 516.)

785. *Automobiles on Hire.* **S. C. Crane.** (Elect. World and Engineer, 34. pp. 927–931, Dec. 16, 1899.)—Management details, and a method of removing accumulators by a truck with turntable are given, as well as efficiency, torque, and speed curves of the Eddy motor. M. O'G.

786. *Overhead Line Construction.* **A. B. Herrick.** (Street Rly. Journ. 15. pp. 865–867, Dec. 1899.)—Notes on the installation and testing of feeders, and the erection of poles.

787. *Electric Railway Practice in Germany.* **L. J. Magee.** (Street Rly. Journ. 15. pp. 647–662, 1899.)—A review of the existing electric traction work in Germany, with tables of financial results, illustrations of power houses, motors, track construction, rolling stock, &c. E. H. C.-H.

788. *Electric Railway Practice in Great Britain.* **S. H. Short.** (Street Rly. Journ. 15. pp. 663–678, 1899.)—A review of British traction work, on the same lines as the article referred to in the previous reference. E. H. C.-H.

789. *Electric Railway Practice in Austria-Hungary.* **E. A. Ziffer.** (Street Rly. Journ. 15. pp. 685–692, 1899.)—An outline of the general practice in the construction and equipment of the 240 miles of electric railways in these countries. E. H. C.-H.

790. *Track Construction in German Cities.* **H. Géron.** (Street Rly. Journ. 16. pp. 49–51, Jan., 1900. Paper read before the Elberfeld meeting of the Verein Deutscher Strassen- und Kleinbahn Verwaltung.)—The author gives the opinions of a number of companies as to different kinds of rails, rail joints, and track constructions for electric cars, and conclusions thereon from experience. Several kinds of rails and joints are illustrated. J. T. R.

TELEGRAPHY AND TELEPHONY.

791. *Wireless Telegraphy at High Altitudes.* **J.** and **L. Lecarme.** (Comptes Rendus, 129. pp. 589–591, 1899.)—Between Mont Blanc (4,350 m. high) and Chamonix (1,000 m.), a distance of 12 km., signalling was uninterrupted by cloud or thunderstorm, although the land surface was free from water in the liquid state. The starting of the 3-phase electric light station at Chamonix entirely stopped possibility of communication. M. O'G.

792. *"Automatic" Telephone Call-Box.* (Electrician, 44. pp. 181–182, Dec. 1, 1899.)—Telephones on the "penny-in-the-slot" principle are largely used in Copenhagen. The inventor of the devices here described is L. M. Ericsson, of Stockholm. A coin of the value of 10 öre (about 1¼d.) is required to operate the calling arrangement. It falls between two forks, which are normally insulated from each other, and makes connection, across the forks, to the exchange. Should the operator give connection to the subscriber wanted and announce the fact, the caller presses one of two buttons, when the coin falls within the case against a gong, to which the microphone is attached, and this is heard by the exchange operator. If, on the other hand, the subscriber wanted is engaged, the caller is thus informed, and, upon pressing the second of the two buttons upon the exterior of the case, the coin is restored by descending a vertical flat tube. Telegrams can be telephoned to the exchange, the operator there informing the caller of the amount to be paid. The necessary coins are then dropped through two slots at the right-hand top corner of the instrument; on their way they strike against gongs, by means of which the operator is acquainted with the amount paid in. About 465 of these instruments are in use. E. O. W.

793. *Telephone Conduit.* **E. Piérard.** (Électricien, 18. pp. 313–314, Nov. 11, 1899.)—In Brussels a layer of slow-setting cement 10 cm. thick is made the bed for glazed pottery tubes. The cement consists of a mixture of calcium carbonate and clay, containing at least 20 per cent of magnesia, and made at least three months before use. The earthenware pipes, 8·4 cm. diam., 46 cm. long, which have an oblique joint, are laid in the bed and cemented in with cement mortar, containing 550 kg. cement per meter cube of sand. The whole is then covered in with cement to a depth of 10 cm. Manholes are used; 400 metres is the length of a run. M. O'G.